VOLUME XXIV NUMBER 4

BOTANICAL GAZETTE

OCTOBER 1897

NOTES ON THE FECUNDATION OF ZAMIA AND THE POLLEN TUBE APPARATUS OF GINKGO.

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(WITH PLATE X)

A PRELIMINARY discussion of the development of the pollen tube apparatus[1] and the antherozoids[2] of Zamia was given by the writer in the June and July numbers of this journal. The object of the present preliminary paper is to call attention to some of the peculiar phenomena which occur during the process of fecundation in Zamia, and to certain features in the development of the pollen tube apparatus of Ginkgo, in which further light is thrown on the origin of the centrosome-like body occurring here as in Zamia.

For a considerable time during the development of the pollen tube apparatus in Zamia the archegonium remains in nearly the same stage of development, simply increasing gradually in size. During this period the very large nucleus remains at the apex of the archegonium as figured by Treub in *Cycas circinalis*.[3] Shortly before fecundation this nucleus divides, and

[1] Peculiar structures occurring in the pollen tube of Zamia. BOT. GAZ. **23**: 453. June 1897.

[2] The development of the antherozoids of Zamia. BOT. GAZ. **24**: 16. July 1897.

[3] Recherches sur les Cycadées. Ann. du Jardin Bot. de Buitenzorg **4**: *pl. 1. fig. 8.*

a small cell is cut off at the apex of the archegonium, which corresponds to the canal cell of the conifers. Until the publication of Ikeno's preliminary note announcing the discovery of this canal cell in *Cycas revoluta*[4] it had been supposed that it was not formed in the Cycadaceæ. It would seem, however, from its occurrence in Cycas and Zamia that it is commonly formed in the Cycadaceæ as in the Coniferæ. Hirase has also recently described the formation of this cell in *Ginkgo biloba*. I have not observed the division of the nucleus leading to the formation of the canal cell in Zamia, but the process probably corresponds very closely to that occurring in Cycas and Ginkgo. Before fecundation the canal cell appears to break up and lose its identity, as only occasional traces of it can be found at that time.

After the division which leads to the formation of the canal cell, the lower nucleus, which forms the oosphere, travels downward and takes a position somewhat below the middle of the archegonium. It is usually spherical or slightly elliptical, and its contents are much less dense than the surrounding cytoplasm of the archegonium with which it forms a marked contrast. The mature archegonium is usually elliptical or slightly reniform and is about 3^{mm} in length and 1 to 1.5^{mm} in width. As explained in my previous papers, several antherozoids commonly enter each archegonium, two being usually found and sometimes three or four. The entire antherozoid enters unchanged, swimming in between the ruptured neck cells. Only one of the antherozoids is concerned in fecundation, and the others are usually found between the protoplasm and wall of the archegonium, presenting their original form and appearance, or in some stage of disintegration. Occasionally one of the antherozoids not concerned in fecundation pushes for a short distance into the contents of the archegonium, but it apparently does not mingle with the protoplasm of the archegonium, as it is always found in such cases to form a distinct body which stains very differ-

[4] Note préliminaire sur la formation de la cellule de canal chez le Cycas revoluta. The Botanical Magazine 10:61. September 1896.

ently. The antherozoid which is utilized in fecundation swims into the protoplasm of the archegonium for a short distance, where it undergoes a remarkable change. In very numerous sections shortly after fecundation the spiral ciliiferous band of the antherozoid which, it will be remembered, is developed by the gradual extension of the membrane of the centrosome-like body, appears uniformly lying in the protoplasm at the apex of the archegonium. It shows very plainly and presents nearly the original form of the antherozoid (*fig. 3*), but all traces of the nucleus and cytoplasm, which originally made up the main body of the antherozoid, have disappeared. The band, preserving its original spiral form, now lies free in the protoplasm of the archegonium. No instance has been found of the occurrence of more than one antherozoid presenting this appearance, and in every fecundated archegonium carefully examined one of these bands has been found. Since it was evident from this that the nucleus of this antherozoid must be the one utilized in fecundation, search was made for intermediate stages. Fortunately several have been found which support this view of the matter. In three different cases, immediately in the rear of the isolated spiral ciliiferous band described above, a nucleus has been found which, judging from its size and appearance, is evidently the nucleus of this antherozoid (*figs. 1* and *2*). I have been unable to determine the fate of the cytoplasm which surrounded the nucleus in the original antherozoid form, but from the slightly different density and constitution of the protoplasm which now lies between the spirals of the ciliferous band, it would seem that it simply unites with that of the archegonium. I have thus far been unable to find any other intermediate stages in the passage of the male nucleus, but it may be assumed from the above observations that shortly after the antherozoid enters the protoplasm of the archegonium, the nucleus escapes from the body of the antherozoid and from this point wanders alone to the oosphere. After fecundation the male nucleus appears as a small nearly round body in the upper portion of the oosphere into which it has penetrated (*fig. 3*).

The contents of the male nucleus is at this time much more dense than that of the oosphere.

The isolated ciliiferous band lying free in the protoplasm at the apex of the archegonium evidently retains its identity for a considerable time. It has been observed in several archegonia after the formation of many free nuclei by the repeated divisions of the oosphere. Frequently the spindles of some of these free nuclei in division have been observed between its spirals. The band ultimately disappears, its substance probably being consumed by the forming embryo. The primary function of the ciliiferous band thus certainly ends with the transporting of the male nucleus from the pollen tube to the archegonium. The exceptional size of the antherozoids of Zamia permits these features to be seen very plainly, while in the various plants in which the entrance of the antherozoids has been studied, they are so small that thus far the fate of the cilia and cytoplasm, which are not generally supposed to be concerned in fecundation, has not been determined with certainty. Professor Strasburger,[5] in his recent study of the fecundation of Fucus, concludes, mostly from comparative size, that shortly after the entrance of the antherozoid its cytoplasm unites with that of the egg cell, and only the nucleus continues its passage and unites with the egg nucleus. My observations clearly indicate that this is the case also in Zamia.

A special examination has been made of the divisions of the oosphere immediately after fecundation for the occurrence of a centrosome which, if present, would be suggestive in connection with the centrosome-like body of the antherozoid. Thus far, however, I have been unable to find any indication of such an organ. Careful examinations have been made of dividing nuclei in many stages of development from the second division of the oosphere until the embryo is fairly well formed. The first division of the oosphere has not been observed. In many cases the kinoplasm may be found presenting somewhat the appearance

[5] Kerntheilung und Befruchtung bei Fucus. Jahrbücher f. wissenschaft. Bot. 30:363. 1897.

of an aster, but in no case has any body been noticed which could be considered a centrosome. Hirase, in his studies of Ginkgo, states that he was unable to find any indication of a centrosome either in the first or the later divisions of the oosphere.[6] It should be remembered in this connection that Overton[7] states that in Ceratozamia the pollen mother cells and endosperm shortly after the formation of the free cells in the embryo sac are very favorable objects for the study of the centrosome. It would seem, however, from Hirase's studies on Ginkgo, my own on Zamia, and the recent cytological studies at the Bonn Botanical Institute, that Overton may possibly have been mistaken.

In the generative cell of *Ginkgo biloba*, according to Hirase,[8] two "attractive spheres" occur which are visible without staining. These organs are unquestionably the same as the centrosome-like bodies which I have described in Zamia. Hoping thus to obtain further information as to the nature and origin of these bodies, I have made a study of the early stages of the development of the pollen tube of Ginkgo. In developing fruits collected June 12, the pollen was found to have germinated and formed a tube about as long as the diameter of the pollen grain. In this stage (*fig. 4*) the vegetative nucleus in all cases examined had already wandered into the tube and was commonly found near its distal end. The stalk cell and generative cell, which, as Strasburger has shown, are formed in the pollen grain before pollination, had at this period increased only slightly in size, and were yet much smaller than the vegetative nucleus. The generative cell in this stage is crescent shaped and projects into the center of the pollen grain. The nucleus is about 5.6μ in diameter and occupies about one-half of the cell. The nucleus of the stalk cell is somewhat smaller, while the vegetative nucleus is much larger, being about 10.5μ in diameter.

[6] Études sur la fécondation et l'embryogénie du *Gingko biloba*. Journ. of the Col. of Sci. Imp. Univ. Japan **8** : 307.

[7] Ueber die Reduction der Chromosomen in den Kernen der Pflanzen. Viertel jahrschr. d. naturforsch. Ges. in Zürich **38** : 178.

[8] Notes on attraction spheres in the pollen cells of *Ginkgo biloba*. The Botanical Magazine **8** : 359.

During June and the early part of July the pollen tube continues gradually to grow in diameter, increasing but slightly in length, until by the middle of July it has reached a diameter somewhat greater than the pollen grain, which at this time forms simply a cap over the proximal end of the tube (*fig. 5*). The generative and stalk cells have increased greatly in size and have pushed out of the pollen grain into the tube, but still remain attached. A careful search was made in the generative cells of material collected at various periods up to this time for the centrosome-like bodies or "attractive spheres" described by Hirase, but in no case was any indication of them discovered. In material collected July 20, however, the centrosome-like bodies were found for the first time (*figs. 5* and *6*). There is considerable variation in the rapidity of development of different pollen tubes in fruits collected the same day, and it was only in the most advanced tubes that the centrosome-like bodies could be found at this time. In material collected July 27 they were found in almost every generative cell examined. Two of the spheres occur uniformly in each generative cell and are located in the cytoplasm on opposite sides of the nucleus about midway between the nuclear membrane and the cell wall (*fig. 6*). They are spherical and of uniform size, but are quite small, being only about 0.6 to 0.7μ in diameter. They are very plainly distinguishable, however, as they stain differently from the surround ing cytoplasm. The radiations of kinoplasm are at this time few in number and comparatively short. They are thick at the base where they join the so-called centrosome-like bodies and are reduced to a very fine point at the end. The generative cell in this stage is usually nearly spherical, being somewhat compressed on the side attached to the stalk cell. It varies in size, being commonly from 25 to 35μ in diameter. The nucleus is spherical, from 16 to 18μ in diameter, and contains a nucleolus. Both the nucleolus and the centrosome-like body are stained bright red with saffranin in using the Flemming triple stain, as in the case of the centrosome-like body and nucleolus of Zamia.

During August the stalk cell and generative cell continue

to increase gradually in size. In material collected August 30 the generative cell was found to have become elliptical in shape, its dimensions being now about 45 by 65μ (*fig.* 7). The nucleus, on the contrary, had become compressed and was now fusiform instead of spherical, its major axis being at right angles to the major axis of the cell. It was commonly about 45μ in length and 18μ in width. The centrosome-like bodies had increased in size, being now from 2 to 2.5μ in diameter. The radiating filaments of kinoplasm were still few and short as in the preceding stage. Between the centrosome-like body and the nuclear membrane on each side of the nucleus a regular spherical body of nearly uniform size, 7 to 8μ in diameter, had made its appearance. It stained bright red with saffranin, the same as the nucleolus and centrosome-like body, but not quite so intensely. The nature and function of these nucleolus-like bodies are still in doubt. That they are not caused by the action of fixatives is quite clear, as Hirase[9] observed them in living unstained generative cells. Furthermore, I find them uniformly in generative cells at this stage, while in a slightly younger stage they do not occur. Zimmermann[10] being unable to account for these bodies suggested that what Hirase supposed to be the nucleus was in reality the generative cell, and that these two nucleolus-like bodies were to be considered as vegetative nuclei. He was, however, mistaken in this interpretation, as will be apparent from an examination of my *figs.* 5 and 7. In several instances spherical masses of similar material have been observed in other locations in the cell. These were smaller and their presence did not apparently affect the size of the main masses situated between the centrosome-like bodies and the nucleus, which were also present in the same cell. The reactions of these bodies to stains would indicate that they may be masses of extra-nuclear nuclein.

The results of my studies on Zamia and Ginkgo are now

[9] On the attraction spheres in the pollen cells of *Ginkgo biloba*. *Ibid.* p. 360; also Études sur la fécondation et l'embryogénie du *Ginkgo biloba*. *Ibid.* p. 318.

[10] Die Morphologie und Physiologie des pflanzlichen Zellkernes 107.

sufficiently complete to enable one to judge quite accurately as to the real nature of the centrosome-like body which occurs in the generative cells of these plants. In Ginkgo the centrosome-like body cannot be detected in the generative cell until two months after the germination of the pollen grain, when the generative cell has greatly increased in size. It then appears as a very small round body in the cytoplasm between the nuclear membrane and the cell wall. It gradually increases in size, and a month later is found to have grown to three or four times its original diameter. It is thus evident that in Ginkgo these bodies originate in the cytoplasm of the generative cell. The early stages of development of the generative cell of Zamia have not been studied, and, therefore, in this case their first appearance has not been observed. It has, however, been determined that they increase in size here as in Ginkgo. In Zamia the centrosome-like body, as described in my previous papers, finally ruptures during the division of the generative cell, and the membrane formed by its wall becomes greatly extended in length, ultimately forming a narrow band arranged in the form of a helicoid spiral on one side of the cell. This band gives rise to the cilia which form the motile organs of the antherozoid. In fecundation, as shown above, this ciliiferous band developed from the centrosome-like body is left in the cytoplasm at the apex of the archegonium, while the nucleus wanders alone from that point to the oosphere. The ciliiferous band surely remains intact at the apex of the archegonium for some considerable time after fecundation, and is then gradually absorbed as the embryo develops. In the divisions of the oosphere immediately following fecundation, furthermore, no indication of any body resembling a centrosome could be found. Hirase, who studied the division of the oosphere of Ginkgo, was also unable to find any trace of a centrosome. It thus seems quite evident from the above facts that the bodies in question cannot be considered as true centrosomes. The mere fact that during a part of their existence they are situated approximately where a centrosome might be expected to occur if present, and for a considerable time during the resting condi-

tion of the nucleus have the kinoplasmic filaments centered upon them, is not sufficient reason for considering them to be centrosomes, when they differ in many other important features. Their origin, function, and fate are totally different from that of any organ known to the writer which has been considered to be a centrosome. If the bodies in question are compared to typical centrosomes such as occur in Fucus, as described by Strasburger,[11] and in Stypocaulon as described by Swingle,[12] the dissimilarity of the two organs becomes striking. The two most important features of a centrosome, namely, continuity from cell to cell, and forming the center of an aster at the pole of the spindle during karyokinesis are not shown by the centrosome-like bodies of Zamia and Ginkgo. In view of our more complete knowledge of the origin, function and fate of the centrosome-like bodies in the two plants under consideration it is evident that they must be considered distinct organs of the protoplasm of spermatic cells, having for their primary function the formation of the motile cilia of the antherozoids. I am not aware that any distinguishing name has been applied to such an organ, and I would here suggest the name *blepharoplast*[13] to distinguish them from other organs of the cell.

In two exceedingly important preliminary papers recently presented before the German Botanical Society, Belajeff has described the occurrence of an organ in the spermatic cells of *Filicineæ*[14] and *Equisetineæ*[15], which is doubtless identical with the blepharoplasts of Zamia and Ginkgo. They apparently originate in the spermatic cells, since no trace of them could be discovered in the spermatic mother cell in the resting condition or during karyokinesis. The first changes visible in the metamor-

[11] Kerntheilung und Befruchtung bei Fucus. Jahrbücher f. wissenschaftl. Bot. **30**: 369. 1897.

[12] Zur Kenntniss der Kern- und Zelltheilung bei den Sphacelariaceen. Jahrbücher f. wissenschaftl. Bot. **30**: 326. 1897.

[13] From βλεφαρις, *eyelash* or *cilium*; and πλαστος, *formed*.

[14] Ueber den Nebenkern in spermatogenen Zellen und die Spermatogenese bei den Farnkraütern. Berichte d. deutsch. bot. Ges. **15**: 337. July 1897.

[15] Ueber die Spermatogenese bei den Schachtelhalmen. Berichte d. deutsch. bot. Ges. **15**: 339. July 1897.

phosis of the spermatic cells occur in these organs. They gradually become extended into a thread which assumes the form of a helicoid spiral of which the extended turns of the posterior end surround the nucleus. The cilia of the antherozoids are developed from the anterior end of this spiral, appearing first as small protuberances on the thread, which finally become greatly extended and form the cilia. It is remarkable that in the comparatively very small spermatic cells of the Filicineæ and Equisetineæ Belajeff should have been able to trace so accurately the method of formation of the ciliiferous band and cilia. The process which he describes as occurring in these plants is identical in all essential features with that which I have described in Zamia, and its publication was almost simultaneous with that of my article.

From previous observations on the spermatogenesis of Characeæ Belajeff is inclined to think that the same organ occurs there also.[16] He further calls attention to the occurrence of somewhat similar organs in the spermatic cells of certain animals.

Belajeff's studies greatly strengthen the view that the blepharoplasts are distinct organs of the cell, differing from centrosomes, and strongly indicates that they occur very generally in the spermatic cells of Filicineæ, Equisetineæ, and Cycadaceæ, if, indeed, they are not of universal occurrence in the spermatic cells of plants and animals.

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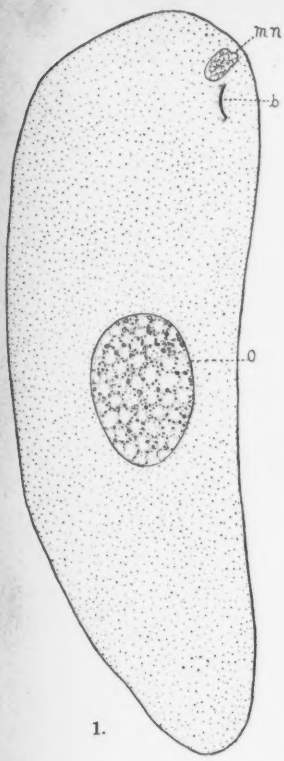
EXPLANATION OF PLATE X.

Zamia integrifolia.

FIG. 1. Archegonium immediately before fecundation by the nucleus of the antherozoid, separated from the ciliiferous band and cytoplasm, lying in the protoplasm at the apex: *o*, oosphere; *mn*, male nucleus; *b*, portion of ciliiferous band. × 30.

FIG. 2. Antherozoid in cytoplasm at apex of the archegonium, with nucleus separated from the ciliiferous band and cytoplasm. × 100.

[16] A more detailed account of Belajeff's discoveries is given under "Notes for Students," p. 302 of this number.



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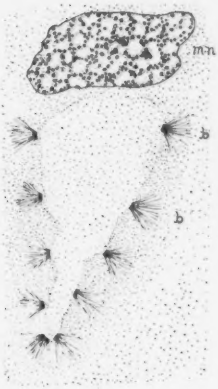

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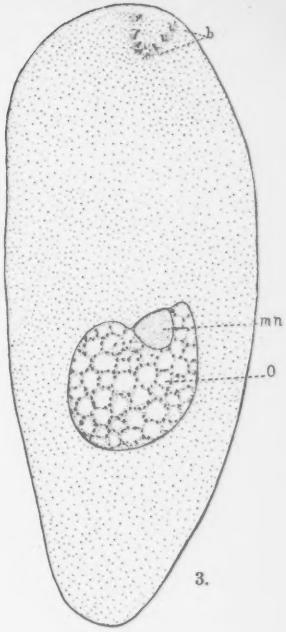

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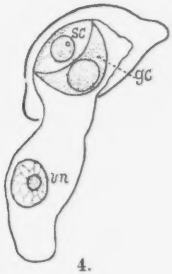

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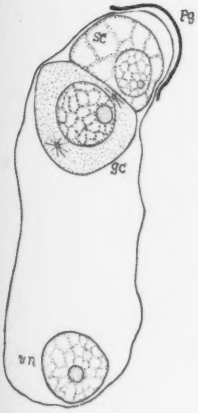

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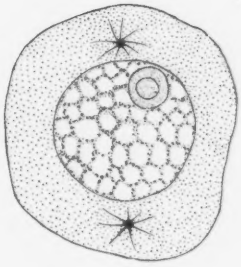

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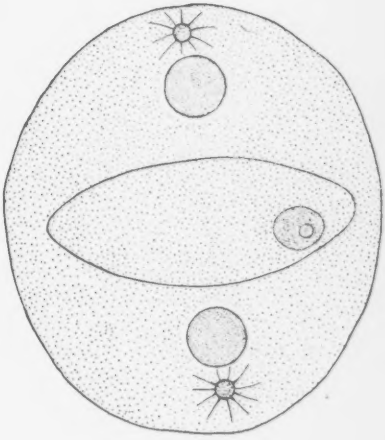

7.

WEBBER on ZAMIA and GINKGO.

FIG 3. Archegonium immediately after fecundation, showing male nucleus (*mn*), in the upper portion of the oosphere; and isolated ciliiferous band of antherozoid producing fecundation at *b*; *o*, oosphere. × 30.

Ginkgo biloba.

FIG. 4. Germinating pollen grain in pollen cavity at apex of nucellus: *gc*, generative cell; *sc*, stalk cell; *vn*, vegetative nucleus. × 500. (From material collected June 12.)

FIG. 5. Germinating pollen grain with generative cell showing blepharoplasts or centrosome-like bodies; *gc*, generative cell; *sc*, stalk cell; *vn*, vegetative nucleus; *pg*, pollen grain. × 500. (From material collected July 27.)

FIG. 6. Generative cell showing blepharoplasts. × 800. (From material collected July 27.)

FIG. 7. Generative cell in a later stage of development, showing the fusiform nucleus and blepharoplasts, and between these the nucleolus-like bodies described by Hirase. × 800. (From material collected August 30.)

NORTH AMERICAN SPECIES OF AMBLYSTEGIUM.

LELLEN STERLING CHENEY.

(WITH PLATES XI–XIII)

INTRODUCTION.

AMERICAN students of bryology have felt for several years that the characterization of the several species of Amblystegium expressed in the descriptions of them now available, are unsatisfactory in many respects. While I was engaged in naming some collections of mosses I met this difficulty and was led to make a closer study of the group, in order, if possible, to discover some clearer diagnostic characters for the several species.

To do such work in the most satisfactory manner the worker should have before him the plants from which the original descriptions were made. Had it been possible for me to prolong this work indefinitely I should have endeavored to see all existing types, notwithstanding the fact that they are widely scattered, and some of them probably available only after months of search. But I have been compelled by circumstances over which I did not have complete control to bring my work to a close without seeing several of the types. In the absence of these, I selected material named by bryologists of recognized ability, compared it carefully with material of other authorities, with the original descriptions and figures, and later ones of good standing, and selected for my descriptions and illustrations those forms which agreed best with the consensus of opinion as expressed in existing descriptions and figures.

In addition to the characters commonly enumerated in descriptions, such as color, general habit, disposition of archegonia and antheridia, I have added some structural characters of both gametophyte and sporophyte, and the averages of a large number of measurements of cells and organs in both.

Such expressions as "a little longer than in the preceding," "shorter than in the former species," etc., are of very little value in the description of any plant, since one man's mole hill may be another's mountain. For the gametophyte I have given the following measurements: length and diameter of stem; length of branches; diameter of central strand when present; diameter of cells in cortex; central strand and ground tissue; dimensions of leaf and leaf cells in three regions, alar, middle, and apical. For the sporophyte measurements were made of the length; the diameter of the seta, its central strand, and the cells of its three tissue regions; the length of the capsule; the dimensions of the exothecium cells and the stomata found on the collum. The averages for the leaf cells were obtained by measuring cells in each of the three regions from five leaves, taking five cells from each region of each leaf. To obtain the average dimensions of leaves a larger number were measured, and for averages of the exothecial cells and those of stomata from ten to twenty or more were measured, whenever there were so many.

In general I have found that the characters of the sporophyte have comparatively little diagnostic value. There are occasional exceptions. For instance, on the collum of the capsule of *A. noterophilum* there are from ninety to two hundred stomata. These are commonly more or less clustered, as many as seven contiguous ones in a single instance being found. In the nearly related species, *A. fluviatile*, the number reaches eighty, while in another related species, *A. irriguum*, the number is usually below forty-five; and in both these species they are scattered.

We must still look to the leaves for the principal characters by which to separate the species. Their shape and size, the size of the cells in the different regions, the presence or absence of a costa and its relative length and diameter are the most available marks. For this reason I have drawn illustrations only of leaves and parts of leaves, with a single exception of *A. noterophilum*. In this case there are no other figures of the capsule known to me.

The student who undertakes the study of Amblystegium must do so with the understanding that he is dealing with a group of exceedingly variable species with many intermediate forms, and must treat them accordingly or meet with disappointment in the end. After long study I am fully convinced that the genus will always prove a troublesome one to the systematist.

HISTORICAL.

The genus Amblystegium was established by Bruch, Schimper, and Gümbel in their *Bryologia Europæa* in 1853, with sixteen species, including *Campylium polygamum* and *Hypnum kneiffii*. Of these, *A. serpens* and *A. riparium* were known to Linnaeus and Dillenius as Hypnum. *A. fluviatile* was described by Swartz in 1799 as *Hypnum fluviatile*, and figured under the same name two years later by Hedwig. Haller described *A. subtile* under the name *H. minimum* in 1768. Hedwig (1801) referred it to Leskea as *L. subtilis*. In this he was followed by Bridel in 1827. *A. confervoides* was described by Bridel in 1812 as *H. confervoides*, and figured by Schwægrichen in 1826 under the name *H. conferva*. *A. radicale* was first described and figured by Hedwig in 1801 as *Leskea varia*, and referred to Amblystegium by Bruch, Schimper and Gümbel, who adopted the specific name applied in 1805 by Palisot de Beauvois to a moss somewhat similar in appearance and supposed to be identical but belonging elsewhere. *A. subenerve*, *A. kochii*, *A. enerve*, *A. oligorrhizon*, *A. curvipes*, and *A. tenuissimum* were established by the authors of the *Bryologia Europæa*. In 1845 Spruce sent a moss to Bruch who in a letter named it *Leskea sprucei*. This is *A. sprucei* of Bry. Eur. *A. irriguum* was described and figured by Wilson in 1855 as *Hypnum irriguum*.

Wilson in the third edition of *Bryologia Brittanica* (1855) did not recognize the genus Amblystegium, choosing to refer the species so named by the authors of Bry. Eur. to Hypnum and Leskea. Schimper however maintains Amblystegium in both editions of his *Synopsis Muscorum Europæorum*, excluding in the first (1860) *A. polygamum*, *A. kneiffii*, and *A. subenerve*,

and adding *A. saxatile* and *A. juratzkanum*. In the second edition (1876) three new species are added, *A. porphyrrhizum* Lindb., *A. leptophyllum* Sch., and *A. hausmani* De Not.; while *A. saxatile* becomes *A. hygrophilum*. In both editions of this work the genus is divided into two subgenera, Amblystegium and Leptodictyum. De Notaris in *Epilogo della Briologia Italiana* (1869) recognizes the genus Amblystegium, but makes it include many Hypna of the Bry. Eur. Milde in *Bryologia Silesiaca* (1869) adopts in all essential features Schimper's conception of the genus, but adds *Hypnum filicinum* Auct. and *H. fallax* Brid. Du Buysson in *Essai analytique du genre Amblystegium* (1883) follows Schimper for generic limits, but reduces several species to varieties. Renauld and Cardot in *Musci Americæ Septentrionalis* (1893) adopt Schimper's limits for the genus. Husnot in *Muscologia Gallica* (1894) does so with Milde's modifications. Dixon and Jameson in *The Student's Handbook of British Mosses* (1896) follow Husnot in large part, but exclude *A. riparium*, which they refer to Campylium. Braithwaite in *British Moss Flora* adopts the limits assigned the genus by De Notaris.

Sullivant in *The Mosses and Hepatics of the United States* (1856) recognizes Amblystegium as a subgenus under Hypnum, adopting in general Schimper's limits, but including *Hypnum polygamum*. In *Icones Muscorum* (1864) Amblystegium is still considered a subgenus of Hypnum. In Lesquereux and James' *Mosses of North America* the arrangement of Sullivant is followed, with the exception of *H. polygamum*, which is placed under the subgenus Campylium. Austin in *Musci Appalachiani* (1870) follows Schimper, but reduces many species of the latter and other authors to the rank of varieties. Macoun and Kindberg in *Catalogue of Canadian Plants* likewise follow Schimper.

GENERIC LIMITS.

To me the generic limits established by Schimper appear to be the most natural ones. As thus defined, the genus includes at least two species, *A. riparium* and *A. vacillans*, whose leaf

structure, considered alone, might place them elsewhere; but when account is taken of the sum of their characters, they must be referred to Amblystegium. I cannot agree, therefore, with Messrs. Dixon and Jameson, who, in their recent admirable *Handbook*, have placed the former in the genus Campylium. Nor can I accept the inclusion of *Hypnum filicinum* and its near relatives in Amblystegium by Husnot in *Muscologia Gallica*, in which he is followed by Dixon and Jameson. Here again the sum of the characters should decide the position of the plant. It appears to me that the very general hypnoid facies, the paraphyllia and the inflated alar cells, together with leaf cells otherwise not entirely of the Amblystegium type, ought to exclude it.

De Notaris, Mitten, Kindberg, and Braithwaite extend the limits of the genus so as to include several other groups of the Hypnaceæ. With these proposals I cannot agree unless we are content to go back to the comprehensive idea of the genus Hypnum. Should I go as far as these authors propose, I can see no reason why I should not include all the Hypnaceæ. The species of Limnobium, for example, are, I think, quite as closely related to the plants included by Braithwaite in Eu-Amblystegium as are the species of Calliergon, which he refers to Amblystegium. Yet the Limnobia are not included.

DISTRIBUTION.

I have been able to separate sixteen species. Ten of these are found both in Europe and North America. Five others, *AA. minutissimum*, *lescurii*, *compactum*, *noterophilum*, and *vacillans*, are exclusively North American. The sixteenth, *A. adnatum*, is found in North America and Japan. Of these, three, *AA. serpens*, *varium*, and *riparium*, are found in most parts of the United States and southern Canada, the first being less common than the others. *A. adnatum* is widely distributed, though not abundant, in the southeastern United States. *A. compactum* may be considered northern, though it extends south in the Rocky mountains to Colorado; *A. sprucei* has a similar distribution, though not found at as many stations; *A. fluviatile*, so far as

known, is northeastern, extending west to Minnesota, and south to Ohio and New Jersey. *A. lescurii* is Appalachian in its range. *A. kochii*, although represented in herbaria from few stations, seems to be widely distributed, being reported from Kansas, Minnesota, and the District of Columbia. *A. vacillans* appears to be eastern and northern, probably local; *A. minutissimum* is central and probably local; the other four are northern. One striking feature in this distribution is the entire absence of any distinctly southern or western forms, though the south has a good variety in *A. riparium floridanum*. It is hardly credible that there is such a dearth of Amblystegia in these regions as appears. No doubt further exploration in the west and south would reveal several forms.

RELATIONSHIPS.

The sixteen species here included fall into three groups, the type group of twelve species of which *A. serpens* is the center, and two small groups. One of these smaller groups contains a single species, *A. lescurii;* the other is made up of *A. riparium* and its varieties, *A. kochii*, and *A. vacillans*.

EXCLUDED SPECIES.

Several species accredited to North America have been excluded in this paper, because with the available material I have not been able to separate them from older species here given. *A. fenestratum* M. & K. is probably not an Amblystegium. It was described from a scrap of sterile gametophyte. *A. speirophyllum* M. & K., also sterile, is probably a form of *A. irriguum* or *varium; A. distantifolium* M. & K. is very near *A. irriguum; A. dissitifolium* M. & K. and *A. subcompactum* are, without doubt, *A. compactum*. *A. holzingeri* R. & C. is *Hypnum* (*Limnobium*) *closteri* Austin. *A. schlotthaueri* was allowed by me to stand in Barnes & Heald's *Key* as a subspecies, but on further comparison with *A. serpens*, I have been unable to separate it from that species. I have not been able to see *A. homalostegium* Jaeg. & Sauerb., a plant collected but once, in Alabama; but from the description

it is so doubtful as an Amblystegium that I have omitted it. *A. curvipes* Bru. & Sch., so far as N. American plants are concerned, must be referred to *A. kochii;* likewise all of the N. American specimens of *A. hygrophilum* Sch. that I have seen are referable either to *Hyp. chrysophyllum* or to *H. radicale* P. B. Some European specimens under the name *A. hygrophilum* must also be referred to Beauvois' plant, which now proves from the type material to be identical with Austin's *Hyp. bergenense* = *H. chrysophyllum*, var. *tenellum* of the L. & J. Manual. These plants are both decidedly nearer Campylium than Amblystegium, and I therefore place them there under Beauvois' old name. I am of the opinion that *A. hygrophilum*, and possibly *A. porphyrrhizum* as well, must be put with *H. radicale*. However, all the material of *A. porphyrrhizum* that I have had an opportunity to examine is only a form of *A. varium*. *A. orthocladon* P. B., from his type material, is *A. fluviatile* Sw. The disappearance of *A. orthocladon* from the list of species of Amblystegium removes one of the worst tangles in the genus. Illustrations and descriptions of Beauvois' types will appear elsewhere at a later date.

NOMENCLATURE.

For nomenclature I have gone back only to Hedwig's *Muscorum Frondosorum*. I do this because of a quite general disposition to make this work the starting point for the nomenclature of the Musci. If the *Species Plantarum* of Linnaeus is to be considered the datum line for all plants, then the name of Linnaeus should take the place of the name in parenthesis after *A. serpens* and *A. riparium*. In the list of works cited in the bibliography, I have included but three prior to the date of *Muscorum Frondosorum*.

ACKNOWLEDGMENTS.

I hope this paper may be the means of clearing up some, at least, of the difficulties attending the study of this genus even by bryologists. Aside from my own efforts, whatever of value it

may have is due to the kind cooperation of friendly bryologists. I gladly acknowledge the assistance thus received from many sources, without which my study would have been impossible, and here express my sense of indebtedness and my thanks for this assistance. Professor Charles R. Barnes of the University of Wisconsin, by giving to me at all times without stint his kindly interest and help in manifold ways, as well as by commanding for my use all the facilities in the power of the University for carrying on my work,[1] has placed me under the greatest obligations. To Mrs. Elizabeth G. Britton of New York, for the use of Amblystegium material in the Columbia University Herbarium, which she placed entirely at my command, and for many other favors; to Professor John Macoun of Ottawa, Ontario, for specimens of several forms not elsewhere available; to Professor John M. Holzinger, of Winona, Minnesota, for the use of type and other specimens; to M. Jules Cardot, of Stenay, France, for material; to Dr. B. L. Robinson, of Harvard University, for type specimens; and to Mr. Frederick V. Coville, of Washington, D C., for books loaned, I offer my sincerest thanks.

AMBLYSTEGIUM Br. & Sch.

Amblystegium Bry. Eur. Monog. Amblystegium. 1853.
Hypnum pp. plur. auct.
Leskea pp. plur. auct.

Gametophyte bisexual rarely unisexual, varying in size from very minute to very large and robust; bright green, dark dull green, yellowish green to yellow or sometimes bronze; prostrate, creeping, decumbent, ascending or erect: stems for the most part slender, soft, occasionally rigid; abundantly and commonly irregularly branched, rarely subpinnate; with or without central strand; sometimes obscurely angled; branches flexuous, ascending or erect: leaves five to eight-ranked, generally spreading

[1] Among the type material which I have consulted none was more useful than specimens from the herbarium of Palisot de Beauvois. All his American types have been sent to the University of Wisconsin for examination through the courtesy of Dr. J. Briquet, curator of the Delessert Herbarium of Geneva, Switzerland. These types will all be studied and illustrated by figures in the course of a few months.

in all directions, sometimes complanate; widely spreading to strict; narrowly lanceolate to broadly ovate, concave or flat, never auriculate or with cells abruptly inflated at the angles, more or less decurrent, wings commonly adhering to the stem when the leaves are separated; ecostate to strongly costate, costa varying from a mere trace at the base to one-third the width of the leaf and long excurrent; margins entire to serrate; cells in the middle leaf region varying from 1:2 to 1:15, hexagonal or rhomboidal, at the leaf base broader and quadrate to long rectangular.

Sporophyte minute to large, 5^{mm} to 4^{cm} long, abundant in most species: seta generally, slender, flexuous, smooth, varying from straw color to dark purple, becoming dull dirty brown with age, central strand well developed: capsule oval to cylindrical, symmetric or asymmetric, erect incurved or horizontal, ordinarily constricted under the mouth in drying, from a large or small collum, uniformly purple or brown, or of two shades, dark on convex side and light on concave side, or pale throughout; exothecium of soft tissue; peristome hypnoid, cilia in a few cases none or rudimentary, usually two to four; operculum convex to conic, usually obtusely apiculate, rarely rostellate; annulus of one to three rows of cells; spores minutely roughened, 12 to 30μ in diameter: calyptra small, fugacious.

ANALYTICAL KEY TO THE SPECIES.

I. *Leaves ecostate or with obscure traces of a nerve.*

Alar cells oblong to linear.

Leaf entire at base, triangular lanceolate . . *A. minutissimum.*

Leaf papillosely serrulate over transverse cell walls, ovate, long acuminate . . . . . *A. sprucei.*

Alar cells quadrate or transversely elongated.

Plants minute (1–2^{cm})

Leaves ovate, acuminate, cells irregular, short 1:2 or less. *A. confervoides.*

Leaves lanceolate, long acuminate, cells regular, 1:3 or more in the middle and apical regions . . . . . *A. subtile.*

Plants twice as large or more . . . . . *A. adnatum.*

II. *Leaves plainly costate.*

A. *Leaves with a distinct border.*

Costa joining border at apex . . . . . *A. lescurii.*

B. *Leaves not bordered.*

* *Costate to apex or nearly so.*

Leaves acuminate, basal cells abruptly enlarged . . *A. irriguum.*

Leaves acuminate, basal cells not enlarged.

Serrate throughout . . . . . *A. compactum.*

Entire, or obscurely serrulate above.

Acumen long, costa ceasing within it . . . *A. varium.*

Acumen short, costa very strong, usually long excurrent. *A. noterophilum.*

Leaves not acuminate, ovate to oblong lanceolate, tip blunt *A. fluviatile.*

* * *Costa disappearing at the middle or above.*

[*A. compactum* may be sought here.]

Cells near the middle of the leaf 1 : 10–15.

Leaves long acuminate, apex sharp . . . . *A. riparium.*

Leaves acute or short acuminate, apex blunt . . . *A. vacillans.*

Cells near the middle of the leaf 1 : 8 or less.

Alar cells quadrate or transversely elongated . . . *A. serpens.*

Alar cells oblong.

Leaves 0.9–1.2×0.25–0.37^{mm} . . . . . *A. juratzkanum.*

Leaves 1.2–1.6×0.5 –0.7^{mm} . . . . . *A. kochii.*

AMBLYSTEGIUM MINUTISSIMUM (S. & L.) Jaeg. & Sauerb. *Plate XI. fig. 4.*

SYNON.: *Hypnum minutissimum* Sulliv. Musci and Hepat. of U. S.—(78) (issue of 1871). 1856.—Sulliv. & Lesq. Icon. Musc. 195. *pl. 120.* 1864.—Lesq. & James Man. Mosses of N. Am. 371. 1884.

Amblystegium minutissimum Jaeg. & Sauerb. Adumb. **2** : 547.—.—Macoun & Kindberg Cat. Can. Pl. 6 : 216. 1892.

EXSICCATI: *Hypnum confervoides* Sulliv. Musci Allegh. 31 (in part). *Hypnum minutissimum* Sulliv. & Lesq. *Musci Bor. Amer.* (1st ed.) 343. (2d ed.) 520 (Herb. Wis.).

TYPE *in Herb. Sulliv.*, Cambridge, Mass.

Gametophyte bisexual, *very minute*, pale green : stems prostrate, appressed, irregularly subpinnately branched, cylindrical, 60 to 110 μ in diameter; central strand none; cortical region of one to two layers of cells, not well differentiated, walls thin, cells

6 to 8μ in diameter; cells of ground tissue 8 to 29μ diameter; branches short, 2.5 to 5^{mm}, erect or spreading: *leaves linear lanceolate*, 90μ wide by 340μ long, varying in width from 70 to 105μ and in length from 280 to 400μ, *usually widest at very base*, tapering regularly to apex, point slender, entire at base, subdenticulate from below the middle to the apex or distinctly denticulate in the upper third, remote, open, spreading in all directions, ecostate or with a second layer of cells in costal region of basal fifth; leaf cells parenchymatous at base, soon becoming prosenchymatous above, *short rectangular in alar region*, averaging 7.5 by 18μ, shorter near the middle of base, occasionally quadrate, 6.7μ in diameter, becoming linear toward middle of the leaf, 5.6 by 40μ, occasionally reaching the extreme length of 60μ, rectangular, rhombic quadrangular or hexagonal; above the middle all prosenchymatous, many slightly vermicular, in the apical region shorter, 5.6 by 34.5μ, occasionally reaching 42μ in length; perichætial leaves long acuminate from an ovate base, coarsely and irregularly dentate above, inner larger than stem leaves, reaching 200μ wide by 750μ long.

Sporophyte small, 5^{mm} long: seta reddish brown below, pale above, 70 to 80μ in diameter, central strand of few rows of cells 15 to 18μ in diameter, cortex of one or two layers of cells 6 to 18.5μ in diameter, cells of ground tissue 9 to 17μ: capsule minute, 0.5^{mm} in length including the operculum, straight or slightly cernuous, oval, occasionally obovate, 1:2, erect, inclined or pendulous, strongly contracted under the mouth, when dry turbinate; cells of exothecium parenchymatous, regular, short rectangular, quadrate, or slightly transversely elongated, average size 20μ wide by 23μ long, walls thin, 1 to 2.5μ thick, two or three rows of cells under the peristome transversely elongated, 18 by 11μ; stomata few, two to six, 21.5μ wide by 26μ long: peristome teeth pale with narrow hyaline border, transversely striate on the back of lower three-fifths, hyaline and papillose above; endostome equaling teeth, membrane about one-half the length of segments, the latter slender, pale, not open along the keel, finely papillose, as are the 1 or 2 slender nodose cilia which equal the segments;

operculum high conic or rostellate from a conic base; annulus of one or two rows of cells, persistent: spores pale, minutely roughened, 8 to 13μ in diameter: calyptra not seen.

HAB.: Growing on limestone rocks in shaded ravines, forming thin, loose patches over the substratum; in company with *Thuidium pygmæum*. Type locality, central and southern Ohio.

Northeastern U. S.: Ohio (Sullivant), Penn., very rare.

A very delicate plant, easily confounded with *A. sprucei* and *A. confervoides*. The leaf characters alone, however, should in most cases be sufficient to separate these three species. In *A. confervoides* the leaf cells are comparatively short and irregular throughout, with a large number in the alar regions quadrate or triangular; while in *A. minutissimum* the leaf cells are much elongated throughout, with the longest cells in the middle of the leaf. *A. sprucei*, while its leaf cells are decidedly elongated throughout, is distinguished from *A. minutissimum* by the leaves papillosely serrulate at base with the longest cell at the very apex. Further, both *A. confervoides* and *A. sprucei* have the widest point of the leaf some distance above the line of insertion, while in *A. minutissimum* the widest point is at the line of insertion, in most cases.

AMBLYSTEGIUM SPRUCEI (Br.) Br. and Sch. *Plate XI. fig. 2.*

SYNON.: *Leskea sprucei* Bruch (*in litt.*) 1845. — Spruce, Lond. Jour. Bot. 180. 1845. — Wilson, Bry. Brit. 330. 1855 (3 ed.).

Hypnum sprucei Bruch (*in litt.*) 1845. — C. Mueller, Syn. Musc. Frond. 2: 415. 1851. — Lesq. & James, Man. Moss. N. Am. 372. 1884.

Amblystegium sprucei Bruch & Schimper, Bry. Eur. Amblystegium 5, *pl. 1*. 1853. — Schimper, Syn. Musc. Eur. 588. 1860 (1st ed.); 705. 1876 (2d. ed.). — Milde, Bry. Siles. 322. 1869. — Hartmann, Handb. Skand. Flora 21. 1871 (10th ed.). — Hobk. Synops. 163. 1873. — Lindberg, Musci Scand. 32. 1879. — R. du Buysson, Essai analyt. du genre Amblystegium. 1883. — Boulay, Musc. Fr. 82. 1884. — Mac. & Kindb. Cat. Can. Pl. 6: 217. 1892. — Husnot, Musc. Gall. 356. *pl. 102*, 1893. — Dixon & Jameson, Handb. Brit. Mosses 441, *pl. 55*. 1896. — Braithwaite, Brit. Moss Flora. 3: 28. *pl. 89*. 1896.

Platydictya sprucei Berkeley, Handb. Brit. Mosses 145. 1863.

EXSICCATI: *Hypnum confervoides* Drummond, Musc. Amer. (Coll. I) 190.

Hypnum sprucei Macoun, Can. Musc. 315 (Herb. Wis.).

TYPE in herb. Bruch, Berlin?

Gametophyte unisexual, minute, slender, densely cespitose, tufts bright green above, not shining, becoming yellow with

age: stems creeping and copiously irregularly branched, cylindrical, 60 to 100μ in diameter; central strand none; cortex of one to two layers of thick walled cells, 5 to 8.4μ in diameter; cells of ground tissue thin walled, 6.5 to 13μ in diameter; branches simple or with few branchlets, 0.5 to 1μ in length, ascending: leaves *lanceolate ovate-lanceolate or ovate*, mostly long acuminate, point very slender, average size 90 by 225μ, varying in length from 100 to 400μ and in width from 60 to 120μ, widest in basal sixth *generally above the line of insertion*, denticulate or subdenticulate to base, *teeth in lower part of leaf formed by single or double papillæ over the transverse walls*, open erect, equally spreading, not appressed but slightly crisped when dry, usually remote, occasionally crowded, ecostate; leaf cells parenchymatous at base, prosenchymatous above, occasionally quadrate, generally long rectangular in alar region, *papillose on the margin over transverse walls*, 8.2μ wide by 12.7μ long, ranging in width from 5 to 9μ and in length from 5 to 22μ, hexagonal to linear-hexagonal in the middle of the leaf, occasionally long rectangular or rhomboidal in the margin, 7μ wide by 27μ long, varying in width from 4 to 8.5μ and in length from 17 to 45μ, linear at apex, 5.5μ wide by 32μ long, varying in width from 4 to 7.7μ and in length from 21.5 to 52μ, apical cell of leaf in most cases the longest; perichætial leaves ovate-lanceolate, acuminate, point filiform, irregularly ciliate dentate, reaching 1^{mm} in length, ecostate, cells short rectangular at base, linear and sometimes slightly vermicular above.

Sporophyte small, 1 to 1.5^{cm} long, *reddish purple throughout at maturity*, fading with age: seta 100 to 120μ in diameter, cortex of one to two layers of well differentiated cells 5 to 9μ in diameter; central strand 12 to 28μ in diameter, composed of 15 to 25 rows of cells; cells of ground tissue 6.5 to 13μ in diameter, walls strongly thickened: capsule symmetric, rarely slightly asymmetric, erect or suberect, subglobose to ovate, 0.5 to 1.5^{mm} long by 0.25 to 5^{mm} wide, slightly or not constricted under the mouth when dry, funnelform; cells of exothecium parenchymatous, regular or irregular, triangular to hexagonal, varying from

oblong (1 : 2.5) to slightly transversely elongated (1.25 : 1), averaging isodiametric (26μ), cell walls 4 to 6μ thick, three to five rows of cells immediately below peristome with thin walls and transversely elongated, 28.8μ wide by 11μ long; stomata five to twelve, scattered, 27.5μ wide by 31.5μ long; peristome one-fourth to one-third length of sporangium,teeth pale yellow, soon becoming hyaline, transversely striate on the back in the lower two-thirds, minutely papillose above; membrane of endostome equaling segments, the latter slender, not open along the keel, equaling the teeth, sparsely papillose; cilia one or two, short, one-third the length of segments, or none; operculum large, hemispherical, mamillate, annulus of one or rarely two rows of cells: spores pale, slightly papillose, 9 to 13μ in diameter: calyptra small, split one half its length.

HAB.: On shaded rocks, earth, twigs, and decaying logs. Type locality, Pyrenees.

Europe, North America: Ontario, mountain region of Canada, Massachusetts, Montana, Idaho, Colorado, New Mexico. Not uncommon locally.

This little moss was first collected by Drummond in Canada and Blytt in Norway, but in both cases it was called *A. confervoides*. As we now know these plants there is little difficulty in distinguishing them by their microscopic leaf characters alone. *A. sprucei* is serrulate throughout and *A. confervoides* entire; the former has elongated cells in the alar regions and linear ones at the apex, while the latter has much shorter cells throughout, being isodiametric in the alar regions and about 1 : 2 at the apex. The leaf characters distinguishing *A. sprucei* from *A. minutissimum* have already been pointed out.

AMBLYSTEGIUM CONFERVOIDES (Brid.) Br. & Sch. *Plate XI. fig. 1.*

SYNON.: *Hypnum confervoides*, Bridel, Spec. Musc. **2**: 153. 1812. Mant. Musc. 167. 1819. Schwægrichen, Spec. Musc. Suppl. 1. **2**: 218. 1816.— Funcke, Moost. 58, *pl. 39*. 1820.— Huebener, Muscol. Germ. 667. 1833.— De Notaris, Syllabus Musc. 11. 1838.— Rabenhorst, Deutschland's Krypt. Flora 2^3: 292. 1848.— C. Mueller, Syn. Musc. Frond. **2**: 414. 1851. Deutschland's Moose 453. 1853.— Hobkirk, Synop. 163. 1873.— Boulay, Musc. Fr. 80. 1884.— Lesq. & James, Man. Moss, N. Am. 372. 1884.

Hypnum conferva Schwaegr. Spec. Musc. Suppl. 2, **1**: 158, *pl. 142*. 1823.

Hypnum jungermanioides Bridel, Bry. Univ. **2**: 549. 1827.

Hypnum stereodon confervoides Bridel, Bry. Univ. 2:583. 1827.

Leskea confervoides Spruce, Lond. Jour. Bot. 4:182. 1845.

Amblystegium confervoides Bruch and Schimper, Bry. Eur. Ambly. 6. *pl.* 2. 1853.—Schimper, Syn. Musc. (1st ed.) 590. 1860. (2d ed.) 707. 1876.—Milde, Bry. Siles. 323. 1869.—DeNotaris, Epi. Bry. Ital. 156. 1869.—Hartmann, Skand. Flora. (10th ed.) 21. 1871.—R. duBuysson Ess. anal. 9. 1883.—Hobkirk, Synop. (2d ed.) 212. 1884.—Macoun & Kindberg, Cat. Can. Pl. 6: 218. 1892.—Husnot, Musc. Gall. 357. *pl. 102.* 1892.—Dixon & Jameson, Stud. Handb. 442. *pl. 55.* 1896.—Braithwaite, Brit. Moss Fl. 3: 27. *pl. 89.* 1896.

EXSICCATI: *Amblystegium confervoides* Austin, Musc. Appl. 368 (Herb. Wis.).

Hypnum minutissimum Sulliv. & Lesq. Musc. Bor. Am. (2d ed.) 520 (Herb. Columbia Univ. in part).

Hypnum confervoides Macoun Can. Musci. 317 (Herb. Wis.).

TYPE in Herb. Bridel.

Gametophyte bisexual, small, cespitose, in thin closely adhering patches, dark green: stems very slender, 60 to 90μ in diameter, not angled, closely and subpinnately branched; branches 0.5 to 1^{cm} long, erect or ascending; central strand none; cortex of two layers of cells, 4.5 to 10.5μ in diameter, differentiated from ground tissue only by the size of cells, those of the latter tissue 9 to 14μ in diameter, thick walled: leaves remote, ovate to ovate lanceolate, 105μ wide by 255μ long, varying in width from 80 to 130μ and in length from 200 to 300μ, attaining their greatest width in the basal sixth but above the line of insertion, straight or rarely falcate, acute or acuminate, *acumen usually stout*, erect spreading, appressed when dry, margin entire, rarely irregularly subdenticulate, ecostate; leaf cells parenchymatous at base and in the margins in the lower half, prosenchymatous in median portion of lower half and throughout all of the upper half, cells in alar region *irregular, quadrate, triangular, or slightly transversely elongated, about three rows extending up the leaf five to ten cells*, 8.2μ wide by 7.5μ long, varying from 7 to 10.3μ long and from 6 to 9.4μ wide, cells above becoming elongate rectangular (1:2–4), cells in the median and apical regions sometimes regular, oval to elliptical hexagonal, more or less flexuose, *oftener irregular, oval, triangular, hexagonal, or rhomboidal*, 7μ wide by 21.5μ long,

ranging in length from 15 to 28μ and in width from 4 to 10.5μ; perichætial leaves elongate lanceolate from a broadly ovate base, abruptly contracted above into a narrow acumen which varies in length from one half the body of the leaf to its full length, denticulate especially at the base of the acumen, ecostate or with very narrow thin costa in the lower third.

Sporophyte small, .75 to 1.5^{cm} long: seta reddish-brown, 90 to 120μ in diameter, cortex of one or two layers of cells 4 to 10μ in diameter, central strand composed of twelve to twenty-five rows of cells 15 to 30μ in diameter, capsule symmetric or slightly asymmetric, suberect to almost horizontal, ovate or cylindrical, not contracted below mouth when dry, incurved, dark dull brown; exothecium cells parenchymatous, oblong rectangular, 21.5μ wide by 34μ long, varying from 13 to 26μ wide and from 17 to 43μ long, lateral walls 3 to 6μ thick, three rows of cells below the mouth hexagonal isodiametric or transversely elongated (17μ); stomata few, six to ten, scattered, 28.5μ wide by 31μ long; teeth of peristome yellow with narrow hyaline border striæ, on the back transverse in the lower three-fourths, above this oblique or longitudinal, giving place finally to rows of long papillæ; endostome light yellow, membrane occupying more than half its entire height; segments strongly carinate, opened slightly along the keel between the articulations, finely papillose, not equaling the teeth, cilia one or two, generally shorter than the segments, sometimes not more than one-third their length; operculum apiculate from a convex or conic base, usually as broad as the capsule; annulus of one or two rows of cells: spores pale, finely tuberculate, 8.5 to 15μ in diameter: calyptra usually shorter than capsule, split little more than half its length.

Hab.: On bowlders in moist woods or on shaded moist limestone cliffs. Type locality Austria.

Europe, Asia, North America: New England, New Brunswick, Ontario, Ohio, along the great lakes, and Rocky mountains. Not abundant.

A small plant, very generally confused with *A. sprucei* and *A. subtile* by American collectors and writers. From the former it may usually be readily

distinguished by characters referred to under that species; from the latter it is distinguished by its smaller cells in the alar region and shorter and more irregular cells in the middle and apical regions. Further, *A. subtile* shows a distinct trace of costa in most leaves and has its parts in general one-half larger.

AMBLYSTEGIUM SUBTILE (Hedw.) Br. & Sch. *Plate XI. fig. 3.*

SYNON.: *Hypnum minimum* Haller, Hist. Stirp. Helvet. 1768.

Leskea subtilis Hedwig, Musc. Frond. **4**: 23. *pl. 9.* 1797. Sp. Musc. 221. 1801.—Swartz, Musci. Sueciæ 69. 1799.—Roth, Fl. Germ. **3**: 335. 1800.—Bridel, Musc. Recent. **3**: 44. 1801. Bry. Univ. **2**: 309. 1827.—Weber & Mohr, Bot. Tasch. 250. 1807.—Rœhling, Deutschl. Flora (2d ed.) **3**: 87. 1813.—Wahlenberg, Fl. Carpat. 356. 1814.—Schwægrichen, Sp. Musc. Suppl. 1. **2**: 176. 1816.—Martius, Flora crypt. Erlang. 48. 1817.—Funck, Deutsch. Moos. 55. *pl. 36.* 1820.—Hübener, Musc. Germ 587. 1833.—DeNotaris, Syl. Musc. Ital. 62. 1838.—Hartmann, Skand. Fl. (10th ed.) 21. 1871.

Hypnum subtile Hoffmann, Deutschl. Flora **2**: 70. 1796.—Smith, Flora Brit. **3**: 1277. 1804.—Palisot de Beauvois, Prodrome 71. 1805.—C. Mueller, Syn. Musc. Frond. **2**: 415. 1851. Deutsch. Moos. 454. 1853.—Sullivant, Musci and Hepat. of U. S. 77. 1856.—Lesq. & James, Man. Moss. N. Am. 372. 1884.

Neckera tenuis Bridel, Mant. Musc. 138. 1819.

Hypnum (*Stereodon*) *serpens* var. *subtilis* Bridel, Bry. Univ. **2**: 649. 1827.

Amblystegium subtile Bruch & Schimper, Bry. Eur. Ambly. 4. *pl. 1.* 1853.—Schimper, Synop. Musc. Eur. (1st ed.) 589. 1860. (2d ed.) 706. 1876.—Milde, Bry. Siles. 322. 1869.—DeNotaris, Epil. Bry. Ital. 155. 1869.—Hartmann, Skand. Fl. (10th ed.) 21. 1871.—Lindberg, Musc. Scand. 32. 1879.—R. du Buysson, Ess. Anal. 1883.—Macoun & Kindberg, Cat. Can. Pl. 6: 217. 1892.—Husnot. Musc. Gall. 356. *pl. 102.* 1894.

EXSICCATI: *Hypnum subtile* Sull. & Lesq., Musc. Bor. Amer. (1st ed.) 342. (2d ed.) 519.—Macoun, Can. Musc. 316. (Herb. Wis.).

Amblystegium subtile Austin, Musc. App. 369. (Herb. Wis.).

TYPE in herb. Haller, Berne, Switzerland.

Gametophyte bisexual, small, widely cespitose, dark green, coherent in tangled felts: stems repent, slender, 60 to 110 μ in diameter, 1 to 3^{cm} long, radiculose to the apex, branched, cylindrical; central strand none; cortex of one or two layers of small cells 6.5 to 10.7 μ in diameter; cells of ground tissue 13 to 21.7 μ in diameter, largest at the center, cell walls uniformly thickened in all tissues with the occasional exception of cells in the outer cortical layer where the wall is thin; branches

numerous, short, 0.5 to 1^{cm} long, erect: leaves not crowded, lanceolate from an ovate base, sometimes linear-lanceolate, *long acuminate*, acumen very slender, 130 μ wide by 440 μ long, ranging in width from 100 to 150 μ and in length from 250 to 500 μ, reaching greatest width in basal fifth, but some distance above the line of insertion, straight or more or less falcate, equally spreading, suberect or subsecund, appressed when dry except the slender points, *entire, with only a trace of costa in basal fifth, this sometimes double or branching* or very rarely wanting; leaf cells parenchymatous at base and along margins in lower half, elsewhere prosenchymatous, *cells at basal angles regular, quadrate or slightly transversely elongated, becoming short rectangular toward the middle, 11 μ wide by 9.5 μ long*, varying in width from 8.5 to 16 μ, and in length from 6.5 to 15 μ, cells in the middle of the lower third oblong, about 1:1.5, those of the middle region irregularly hexagonal, occasionally slightly flexuose, 8.2 μ wide by 26 μ long, ranging in width from 6.5 to 10 μ and in length from 19 to 32 μ, cells in apical region much as in median region, but regularly somewhat longer, the terminal cell in most cases being the longest in the leaf blade, varying in width from 6.5 to 9.5 μ and in length from 15 to 44 μ, averaging 8 μ wide by 30.5 μ long; outer perichætial leaves abruptly long acuminate from a broadly ovate base, acumen equaling the body, ecostate or with a trace of costa at base, inner leaves much larger, linear lanceolate, abruptly acuminate, acumen one-half the length of the body, costate to middle or beyond, costa thin but distinct, all entire.

Sporophyte small, 1^{cm} long, cinnamon brown: seta flexuous in upper third, 120 to 150 μ in diameter, central strand 16 to 19 μ in diameter, composed of ten to eighteen rows of cells, cortex of two or three layers of cells, with walls moderately thickened, 6.5 to 13 μ in diameter, cells of ground tissue 13 to 21.5 μ in diameter, largest near the central strand: capsule oblong cylindrical, 1 to 1.5^{mm} long including operculum, symmetric or moderately incurved, erect, becoming more or less inclined by the bending of the seta, only slightly contracted under the mouth in drying, collum shrivelling and becoming wrinkled, wall of

capsule thin and flaccid, cells of exothecium parenchymatous, varying from quadrate to oblong, 22 μ wide by 46 μ long, varying in width from 13 to 26 μ and in length from 21 to 80 μ, walls uniformly thickened, 4 μ, three to five rows of cells below the mouth hexagonal, 13 to 21.5 μ in diameter, stomata eight to fifteen, scattered, 27 μ wide by 35 μ long; peristome teeth pale yellow with hyaline border, lance-linear, striæ on the back transverse in lower two thirds, oblique above or replaced by irregularly scattered papillæ, endostome equaling the teeth, one-third to one-half the length of the segments, the latter linear, carinate, open along the keel between the articulations, sparsely papillose, cilia very rudimentary or none, operculum high convex to conic, obliquely apiculate; annulus of one or two rows of cells: spores pale, 10 to 16 μ in diameter: calyptra equaling the capsule, split more than half its length.

HAB.: On bases of tree trunks, chiefly maple, beech and willow; rarely on shaded rocks. Type locality Switzerland.

Europe, Asia, North America: New England, New York, New Jersey, Ontario, and westward along the Great Lakes to Wisconsin and Minnesota. Not rare.

This with the preceding three species, on account of their uniformly small size, form a group, all of which are usually easily distinguished from all other members of the genus, though small forms of *A. adnatum* and *A. serpens* may sometimes be mistaken for them. The former has leaves proportionately broader, more abruptly and shorter pointed, with cells very regular and uniformly larger in upper parts of leaf. The latter usually shows a distinct costa in the lower third of the leaf.

AMBLYSTEGIUM ADNATUM (Hedw.) Aust. *Plate XI. fig. 5.*

SYNON.: *Hypnum adnatum* Hedwig, Spec. Musc. 248. *pl. 64. f. 5–10.* 1801.— Palisot de Beauvois, Prodr. 61. 1805.— Bridel, Spec. Musc. **2**: 160. 1812. Mant. Musc. 168. 1819.— Schwægrichen, Spec. Musc. Suppl. **1. 2**: 215. 1816.— C. Mueller. Syn. Musc. Frond. **2**: 339. 1851.— Sullivant, Musc. and Hepat. of U. S. 78. 1856. Icon. Musc. 197. *pl. 121.* 1864.— Lesquereux & James, Man. Moss. N. Am. 375. 1884.

Hypnum (*Stereodon*) *adnatus* Bridel, Bry. Univ. **2**: 591. 1827.

Amblystegium adnatum Macoun & Kindberg. Cat. Can. Pl. 6: 220. 1892.

EXSICCATI: *Hypnum adnatum* Sulliv. & Lesq., Musc. Bor. Amer. (1st ed.) 344. (2d ed.) 521, 522.— Macoun, Can. Musc. 322, 323 (Herb. Wis.).

Amblystegium adnatum Austin, Musc. App. 370. 1870.

TYPE in Herb. Hedwig.

Gametophyte bisexual, depressed, in wide thin mats, yellowish, pale green or sometimes dark green, closely adhering to the substratum: stems irregularly branching, creeping, 2 to 4^{cm} long, slightly flattened, the two diameters usually 4:5, 140 by 175 μ in diameter, ranging from 100 by 125 μ to 180 by 225 μ; central strand none; cortex of three or four layers of cells, 6.5 to 14 μ in diameter; cells of ground tissue 10 to 22.5 μ, largest near the center, cell walls noticeably thickened; branches numerous, very short, 2 to 5^{mm}, erect: leaves crowded, erect spreading, *ovate or oblong, abruptly short acuminate, acumen broad,* concave, *entire* or occasionally irregularly denticulate, *usually with a thin simple branched or double costa in basal fifth,* 345 μ wide by 820 μ long, varying in width from 300 to 380 μ and in length from 800 μ to more than a millimeter; leaf cells in all but alar regions prosenchymatous, *cells of basal angles regular, quadrate,* slightly transversely elongated or occasionally oblong, 13.9μ wide by 9.2 μ long, varying from 12 to 17 μ in width and from 6.4 to 15 μ in length, toward the middle of the base *changing abruptly to long hexagonal,* almost vermicular, walls thin, usually thicker and firmer in the middle region, cells varying in width from 4.3 to 8.6 μ and in length from 28 to 58 μ, averaging 6.5 μ wide by 42.8 μ long, toward apical region gradually changing from hexagonal to rhomboidal, 8.8 μ wide by 24.6μ long, ranging in width from 6.9 to 10.6μ and in length from 17 to 32μ, longest cells in the middle of the leaf; *in general the leaf cells very regular in all parts,* the alar quadrate cells sometimes extending as much as one third the length of the leaf; outer perichætial leaves broadly ovate, gradually acuminate, acumen half the length of the body, spreading, inner leaves ovate to oblong abruptly acuminate, acumen short, one fifth to one fourth the length of the body of the leaf, strict, all irregularly denticulate to dentate above the middle and costate to the middle, costa evident,

thin, occasionally simple, usually branched near the base or double.

Sporophyte small 0.5 to 1.5^{cm} long: seta purplish below, pale above, 140 to 18μ in diameter; central strand well differentiated, large, 35 to 58μ in diameter, composed of thirty-five to fifty rows of cells; cortex of two to three layers of cells 4.3 to 10.7μ in diameter, walls very strongly thickened, as are those of the ground tissue, the latter cells 12 to 17μ in diameter: capsule oblong to obovate, incurved from an erect base, asymmetric, gradually contracted to the seta, brownish purple throughout or paler on the concave side, usually more or less constricted under the mouth and the latter dilated in drying, 1.5 to 2^{mm} long, wall thin; cells of exothecium parenchymatous on the concave side, 25.7μ wide by 38.6μ long, ranging in width from 17 to 28μ and in length from 21 to 64μ, on the convex side more or less prosenchymatous, 20μ wide by 62μ long, ranging from 13 to 21.5μ wide and from 34 to 79μ long; walls of cells from 2 to 4μ, thicker on the concave side, three to six rows of isodiametric, hexagonal cells under the peristome 13 to 22μ; stomata few, eight to fourteen to the capsule, 25μ wide by 36μ long; peristome teeth linear-lanceolate, very slender pointed, transversely striate on the back below the middle, densely papillose above, hyaline border very narrow or none below, wider and serrate above, teeth yellow; endostome almost equaling the teeth, finely papillose in all parts, membrane narrow, one half the length of the segments, the latter lance-linear, perfect, entire, often not split along the keel, never gaping; cilia one or two, slender, nodulose, nearly equaling the segments; operculum equaling capsule in width, convex to high conic, obliquely apiculate or rostellate; annulus broad, of two to three rows of cells: spores light brown, surface minutely roughened, 8 to 12μ in diameter: calyptra equaling the capsule, split half its length.

HAB.: On shaded rocks, occasionally at base of trees. Type locality Lancaster, Pennsylvania.

Japan, North America: New Brunswick, Ontario, region of the Rocky mountains, New England, New York, District of

Columbia, New Jersey, Ohio, West Virginia, Wisconsin, Minnesota and Texas. Not rare.

This moss has in several instances been confused with *Hypnum reptile*. The likeness between the two forms however is only in general appearance and size. Once the leaves of the two are subjected to a microscopical examination no difficulty need be experienced in separating them, the leaves of *H. reptile* being long and gradually acuminate and strongly serrate in the upper half, generally distinctly falcate and secund. Between *A. adnatum* and *A. subtile* there are occasional forms which are puzzling in the absence of the sporophyte, but usually the size of the leaf and dimensions of the leaf cells are sufficient to separate them.

AMBLYSTEGIUM SERPENS (Hedw.) Br. and Sch. *Plate XI. fig. 6.*

SYNON.: *Hypnum serpens* Hedwig, Musc. Frond. **4**: 45. *pl. 18.* 1797. Spec. Musc. 268. 1801.— Swartz, Musc. Frond. Suec. 65. 1799.— Bridel, Musc. Recent. 2^2: 111. 1801. Spec. Musc. **2**: 243. 1812. Mant. Musc. 183. 1819. Bry. Univ. **2**: 642. 1827.— Smith, Fl. Brit. 1306. 1804.— Turner, Muscologiæ Hibernicæ Spicilegium 169. 1804.— Palisot de Beauvois, Prodr. 70. 1805.— Schultz, Prodromus Floræ Stugardiensis 322. 1806.— Weber and Mohr, Bot. Tasch. 300. 1807.— Wahlenberg, Fl. Lapp. 376. 1812. Fl. Carpat. 359. 1814.— Roehling, Deutschl. Fl. **3**: 110. 1813.— Schwægrichen, Spec. Musc. Suppl. 1. **2**: 260. 1816.— Martius, Cr. Erl. 15. 1817.— Hooker and Taylor, Muscologia Brittanica 94. 1818.— Hooker, Flora Scotica **2**: 142. 1821.— Funck, Moost. 50. *pl. 45.* 1821.— Gray, Nat. Arr. Brit. Pl. **1**: 754. 1821.— Huebener, Musc. Germ. 679. 1833.— De Notaris, Syl. Musc. Ital. 10. 1838.— Rabenhorst, Deutsch. Krypt. Fl. 2^3: 292. 1848.— C. Mueller, Syn. Musc. Frond. **2**: 411. 1851. Deutschl. Moos. 454. 1853.— Wilson, Bry. Brit. 362. 1855. Sullivant, Musc. and Hepat. U. S. 78. 1856.— Berkeley, Handb. Br. Moss. 96. 1863.— Hobkirk, Syn. of Brit. Mosses. 163. 1873.— Boulay, Musc. Fr. 79. 1884.— Lesquereux and James, Man. Moss. N. Amer. 373. 1884.

Hypnum spinulosum Hedwig, Spec. Musc. 269. *pl. 69. f. 5–10.* 1801.

Hypnum contextum Hedwig, Spec. Musc. 273. *pl. 72. f. 5–12.* 1801.

Amblystegium serpens Bruch and Schimper, Bry. Eur. Ambly. 9. *pl. 3.* 1853.— Schimper, Syn. (1st ed.) 591. 1860. (2d ed.) 709. 1876.— Milde, Bry. Siles. 323. 1869.— De Notaris, Epi. Bry. Ital. 153. 1869.— Hartmann, Skand. Fl. (10th ed.) 20. 1871.— Hobkirk, Syn. 212. 1884.— Lindberg, Musc. Scand. 1879.— Macoun and Kindberg, Cat. Can. Pl. 6: 218. 1892.— Husnot, Musc. Gall. 357. *pl. 102.* 1893.— Dixon and Jameson, Stud. Handb. 442. *pl. 56.* 1896.— Braithwaite, Brit. Moss. Fl. **3**: 23. *pl. 89.* 1896.

Amblystegium serpens subsp. *schlotthaurri* Renauld and Cardot, Bot. Cent. **51**: —. 1890.

EXSICCATI: *Hypnum serpens* Sulliv. and Lesq., Musc. Bor. Amer. (1st ed. 345. (2d ed.) 523.— Macoun, Can. Musc. 318 (Herb. Wis.).

Amblystegium serpens Austin, Musc. App. 373.

TYPE probably not in existence. The plant is supposed to have been described as early as 1696 by Ray.

Gametophyte bisexual, *small or of medium size*, usually densely cespitose, occasionally in loose mats, sometimes bright green, oftener dull yellowish green: *stems prostrate, generally much branched, slender, weak*, 100 to 150μ in diameter, 1 to 3^{cm} long; central strand well differentiated though small, 13 to 20μ in diameter, composed of eight to fifteen rows of cells; cortex of one or two layers of cells with walls moderately thickened, cells 6.5 to 13μ; cells of ground tissue 13 to 30μ in diameter; branches ascending or erect, flexuous with few branchlets .5 to 1.5^{cm} long: leaves ovate lanceolate to narrowly lanceolate, 320μ wide by 800μ long, varying in width from 260 to 360μ, and in length from 500μ to more than a millimeter, usually serrulate in upper two-thirds, flat or concave at base, *generally long acuminate*, occasionally subsecund, costate, *costa thin, weak, reaching to near the middle*, occasionally beyond (three-fifths the length of the leaf), or sometimes very short, occupying one sixth the leaf base at the line of insertion, 25 to 35μ wide, maximum width of leaf in basal sixth, upper two fifths a long slender acumen, leaf gradually widening below, when moist erect or open-spreading, in the dry condition either open or appressed; leaf cells parenchymatous below, those of the alar regions short rectangular to slightly transversely elongated, 17.4μ long by 15.3μ wide, varying from 13 to 18μ in width and from 15 to 19μ in length, in the costal region of base cells usually longer, the quadrate alar cells extending up to widest point of the leaf, there giving place to rectangular ones which in turn are soon succeeded by regularly hexagonal cells; those of middle lamina 11μ wide by 42μ long, ranging from 9 to 13μ wide and from 30 to 55μ long, the longest cells however usually being found in the long slender acumen, where they sometimes reach 60μ, varying in width from 11 to 13μ and in length from 40 to 60μ, averaging 12μ wide by 45μ long; perichætial leaves triangular lanceolate to oblong, erect, some-

times abruptly acuminate, acumen short, broadly costate to apex; outer triangular lanceolate, erect or slightly spreading; inner much larger, oblong, all costate, costa distinct, excurrent, forming a slender short acumen.

Sporophyte small to medium, 1^{cm} (rarely less) to 3.5^{cm} long: seta slender, 180 to 240μ in diameter, flexuous above, reddish brown at base, stramineous above; central strand well differentiated, 25 to 33μ in diameter, composed of thirty to forty rows of cells; cortex of three to five (usually four) layers of cells 6.5 to 13μ in diameter; cells of ground tissue 13 to 21.5μ: capsule 1.5 to 3^{mm} long, cylindrical or occasionally thickest at the mouth, tapering regularly from there to the seta, asymmetric, suberect to strongly incurved, collum one sixth the length of the sporangium, reddish or yellowish brown, frequently of two shades, becoming dull dirty brown with age, when empty frequently strongly incurved and constricted below the mouth; cells of the exothecium more or less prosenchymatous on the convex side, 23.5μ wide by 51.5μ long, varying from 13 to 37μ wide and from 30 to 82μ long, parenchymatous on the concave side, 25.5μ wide by 38.5μ long, ranging in width from 17 to 39μ and in length from 21 to 65μ, cell walls 3 to 4μ thick, three to five rows of cells under peristome isodiametric hexagonal, sometimes transversely elongated, 10.5 to 25μ in diameter; stomata eighteen to twenty-five, scattered, 42μ wide by 48μ long, ranging from 37 to 47μ wide and from 42 to 56μ long; peristome teeth lanceolate, dull brown below, pale above, marginal serrulate above, transversely striate on the back to beyond the middle, above this point faintly papillose; endostome equaling or slightly exceeding the teeth; membrane two thirds the length of the segments, the latter lanceolate, carinate, split along the keel between the articulations though scarcely gaping, papillose, as are also the one to three nodulose cilia which scarcely equal the segments; operculum apiculate from a highly convex or conic base; annulus broad of two or three rows of cells: spores finely papillose, light brown, 12 to 15μ in diameter: calyptra equaling capsule or shorter, split one half its length.

HAB.: On earth in moist places, at roots of trees and on decaying wood. Type locality England.

Found all over the world. Widely distributed in North America though less common than *A. varium*.

Amblystegium serpens stands as the type species around which the other members of the genus group themselves. It is a remarkably variable species though having few well marked varieties. It is most easily confounded with two of its close relatives *A. juratzkanum*, which by many is made a variety of it, and *A. varium*. *A. juratzkanum* is distinguished by having its leaves widely spreading and having its parts uniformly larger and its leaf cells longer at the base of the leaf. *A. varium* is generally a larger plant than A. *serpens*, has broader leaves, somewhat smaller cells throughout, and commonly has its leaves costate well towards the apex. Notwithstanding the differences in the well-marked forms, there are forms between them which will never cease to puzzle bryologists.

AMBLYSTEGIUM JURATZKANUM Schimp. *Plate XI. fig. 7.*

SYNON.: *Amblystegium juratzkanum* Schimper, Syn. (1st ed.) 693. 1860. 2d ed.) 710. 1876.—Milde, Bry. Siles. 327. 1869.—Hartmann, Skand. Fl. (10th ed.) 19. 1871.—Husnot, Musc. Gall. 358. *pl. 102.* 1893. Flora Batavia, *pl. 939.*

Hypnum juratzkanum Boulay, Musc. Fr. 74. 1884.

Amblystegium serpens juratzkanum R. duBuysson, Étude du genre Amblys. 18. 1889.

Amblystegium juratzkæ Macoun & Kindberg, Cat. Can. Pl. 6:218. 1892.

Amblystegium juratzkæ Braithwaite, Brit. Moss Fl. 3: 25. *pl. 91.* 1896.

EXSICCATI: *Hypnum juratzkæ* Macoun, Can. Musc. 466.

TYPE in herb. Schimper.

Gametophyte bisexual, of medium size, loosely *cespitose*, bright green, becoming yellow below with age: stem slender, 2 to 4^{cm} long, 120 to 180 μ in diameter, cylindrical, prostrate, branched; central strand small and poorly developed or none, when present 8 to 17 μ in diameter, composed of three to ten rows of cells; cortex thin, not well differentiated, of one layer (rarely two) of cells 8.5 to 17 μ in diameter; cells of ground tissue 13 to 26 μ; primary branches few, prostrate; branchlets numerous, erect or ascending: *leaves linear lanceolate* to ovate lanceolate, *narrowly long acuminate, acumen equaling or exceeding the body of the leaf*, attaining greatest width in basal fifth, *serrulate to the base*, costate, costa

thin but distinct below, extending one half to two thirds the length of the leaf, one seventh to one fifth the entire width of leaf base at line of insertion, *widely spreading in both moist and dry conditions*, flat and straight or slightly concave at base, average leaves 300μ wide by 1050μ long, varying in width from 250 to 370μ and in length from 800 to 1200μ, leaves in smaller forms approaching those of *A. serpens* in form and size and in the larger forms reaching a length of 1400 to 1500 μ; leaf cells short oblong, rectangular, or rarely quadrate across the base, prosenchymatous above, hexagonal in the middle, *generally linear-hexagonal in the upper half of the acumen, longest cells usually found above the end of the costa*, alar cells 13.4μ wide by 24.4μ long, varying in width from 10 to 17μ and in length from 17 to 40μ, towards the middle 11.3μ wide by 52.4μ long, ranging in width from 8.5 to 13μ and in length from 40 to 70μ, and at the apex usually a little longer and narrower, 10.2μ wide by 63μ long, varying in width from 8.5 to 12.5μ and in length from 40 to 85μ; perichætial leaves triangular lanceolate or ovate lanceolate, pale, strict, short acuminate by the excurrent costa.

Sporophyte of medium size, 1.5 to 3^{cm} long: seta 180 to 300μ in diameter, flexuous above, red at base, yellow or pale brown above; cortex of two to four layers of cells 6.4 to 17μ in diameter; central strand well developed, 35 to 45μ in diameter, composed of fourteen to forty-five rows of cells; cells of ground tissue 13 to 35μ; capsule 2.5 to 3.5^{mm} long, slender, cylindrical, asymmetric, either moderately or strongly incurved from an erect base, slightly constricted under the mouth when dry, pale at maturity, usually light brown on the convex side and yellow on the concave side, frequently becoming darker colored when empty, collum slender, about one-fourth the length of the sporangium; exothecium cells mixed prosenchymatous and parenchymatous on the convex side, 34μ wide by 90μ long, varying in width from 17 to 51.5μ and in length from 47 to 110μ, parenchymatous on the concave side, 38.5μ wide by 64μ long, ranging from 21.5 to 56μ wide and from 30 to 90μ long, cell walls variable, 2 to 6μ thick, two to four rows of cells

under the peristome smaller, hexagonal or tranversely elongated, from 13 to 26μ long and from 18 to 36μ wide; stomata twenty-five to thirty-five to the capsule, scattered, 40μ wide by 50μ long; teeth of peristome lanceolate, pale yellow, long acuminate, margined, margin narrow at base becoming gradually wider above, reaching its greatest width about the middle, teeth serrulate above, transversely striate to the middle, here the striæ becoming irregular, some being oblique and some perpendicular, farther up the striæ replaced by papillæ which are scattered irregularly or arranged in parallel rows; endostome equaling the teeth or a little shorter, membrane one-half to three-fifths the length of the segments, the latter lanceolate, very slender pointed, perfect, carinate, open along the keel between the articulations but not gaping, membrane and segments finely and densely papillose as are the one to three stout cilia, the latter shorter than the segments; operculum convex to conic, apiculate; annulus of two rows of cells: spores light brown, finely punctulate, 15 to 18μ in diameter: calyptra two-thirds the length of the capsule, split half its length.

HAB.: On moist stones or earth. Type locality lower Austria.

Europe, Asia, North America: District of Columbia, Ontario, Wisconsin, Montana, Idaho, and British Columbia. Not common.

This species is very closely related to *A. serpens* by all its characters and small forms of it are difficult to distinguish from the latter. It is commonly of larger size throughout and has its leaf cells at base more commonly elongated. The general habit of the plant will usually aid in identifying it; the leaves are always widely spreading but not bent as is the case with *Campylium chrysophyllum*. From small forms of *A. riparium*, especially *A. riparium floridanum*, it may be found troublesome to separate it. The leaves of forms of *A. riparium* are entire, while those of *A. juratzkanum* are serrulate to the base.

AMBLYSTEGIUM COMPACTUM (C. Muell.) Aust. *Pl. XI. fig. 8.*

SYNON.: *Hypnum compactum* C. Mueller, Syn. Musc. Frond 2: 408. 1851. —Sullivant, Icon. Musc. 201. *pl. 123*. 1864.—Lesquereux & James, Man. Moss. N. Amer. 375. 1884.

Amblystegium serratum Bruch & Schimper, Bry. Eur. Ambly. 11. 1853.

Stereodon compactus Mitten, Jour. Linn. Soc. **8**: 43.

Amblystegium compactum Macoun & Kindberg, Cat. Can. Pl. 6: 1892.

EXSICCATI: *Amblystegium compactum* Austin, Musc. App. 372; Macoun, Can. Musc. 324 (Herb. Wis.).

Hypnum serpens var. *compactum* Hookerin Drummond's Musc. Amer. 188.

TYPE in Herb. Hooker, Kew.

Gametophyte bisexual, of medium size, *usually in dense tufts from 0.5 to 2.5*^{cm} *deep*, sometimes forming loosely woven mats, pale green above, becoming yellow or rust colored below with age: stems slender 2 to 3^{cm} long, 120 to 190μ in diameter, rarely reaching 220μ, obscurely five angled, erect, ascending or occasionally almost prostrate, soft and flexible when moist, *fragile when dry, fasciculately branched*, tomentose radiculose to near the apex; central strand small, 3 to 6μ in diameter, of four to seven rows of cells, cells of ground tissue 13 to 32μ in diameter, cortex of one or two layers of cells 4.5 to 13.6μ, all tissues *having thin walls;* branches slender, short, 0.4 to 1^{cm} long, erect with tips generally inclined or curved, closely foliate; leaves lanceolate to ovate lanceolate, *more or less long and narrowly decurrent*, attaining greatest width in the basal fifth, usually near the line of insertion, 260μ wide by 780μ long, varying in width from 180 to 350μ and in length from 550 to 1000μ, in extremely large leaves reaching 500μ wide by 1200μ long, erect spreading crowded, not appressed when dry, straight or slightly falcate, gradually acuminate, acumen broad to tip, costate, costa generally *percurrent or nearly so*, rarely ceasing just above the middle, strong at base, sometimes thin and divided above or disappearing entirely for a short distance, one-fifth to one-sixth the leaf base at line of insertion, 30 to 50μ wide; dentate or rarely almost entire at the base, *teeth formed of a single or a double papilla over the transverse wall or by the protrusion of the adjoining corners* of the marginal cells above, the teeth being of the ordinary form, but frequently recurved; leaf cells parenchymatous across the base, somewhat abruptly and regularly prosenchymatous above, those of the alar regions (excluding the decurrent wing) quadrate to short rectangular, 8.6μ wide by 11.7μ long, ranging from 7 to 12.5μ wide and from 8.5 to 19μ long, those near the

costa being somewhat longer, the marginal row in the middle of the leaf rhomboidal with the marginal wall regularly thicker than (often twice as thick as) other walls of the same cell or the walls of other cells of the middle lamina, the latter oval to linear hexagonal, 6.5 μ wide by 47.6 μ long, varying in width from 4.7 to 8.6 μ and in length from 38 to 64.5 μ, at the apex of the leaf cells shorter and broader, sometimes irregular, 7.9 μ wide by 20.8 μ long, ranging from 5 to 8.6 μ wide and from 15 to 30 μ long; perichætial leaves oblong lanceolate, abruptly acuminate, acumen one-fifth the length of the body, serrulate in the upper third, entire below, costate, costa narrow, percurrent or excurrent.

Sporophyte small or medium, 1 to 3^{cm} long: seta slender, 130 to 160 μ in diameter, brown or purplish brown throughout, or paler above; central strand small, 17 to 22 μ in diameter, of six to eight rows of cells, cortex of one or two layers of cells 4 to 11 μ in diameter, beneath these the cells of the ground tissue abruptly larger, 15 to 30 μ: capsule 1.5 to 3^{mm} long, symmetric or asymmetric, erect or inclined, chestnut brown to brownish purple, constricted under the broad and slightly dilated mouth when dry; exothecium cells parenchymatous, generally regular, quadrate to short rectangular, walls very thick, 5 to 9 μ, cells 21 μ wide by 31.5 μ long, varying in width from 11 to 34 μ and in length from 21 to 60 μ, four to six rows of hexagonal transversely elongated cells under the peristome 24 μ wide by 14.3 μ long; stomata twelve to thirty to the capsule, 30 μ wide by 38.5 μ long; collum prominent, long, one-half the length of the sporangium; teeth of peristome lanceolate to linear lanceolate, yellow below, paler and narrowly margined above, densely and finely papillose on the back above, transversely striate in the lower half or occasional areas in lower half covered with papillæ arranged in transverse rows; endostome pale yellow, finely papillose, shorter than the teeth, membrane equaling the segments or nearly so, the latter lanceolate, carinate, open along the keel between the articulations, not gaping; cilia one or two, short and broad or obsolete; operculum high conic or apiculate from a convex base,

broad; annulus of one or two rows of cells: spores papillose, 15 to 21.5μ in diameter: calyptra small, one-third to one-half the length of the capsule, split one-half to three-fifths its length.

HAB.: On decayed wood, at the bases of trees in swamps or along streams. Type locality North America (Drummond).

North America: New Brunswick, Ontario, Lake Huron, Pennsylvania, New York, Wisconsin, Canadian Rocky mountains, Montana, Nevada, Utah, Colorado, California, and Washington. Widely distributed and not uncommon.

A well marked species, the habit of growth in more or less dense tufts being sufficient ordinarily to separate it from all of its relatives; further the strong and peculiar serration of its leaves mark it at once. After carefully examining all the material known to exist in America of *A. subcompactum* Kindb. and *A. dissitifolium* Kindb., I have been unable to separate them from *A. compactum*, though they differ from the typical form in some small degree.

AMBLYSTEGIUM VARIUM (Hedw.) Lindb. *Plate XI. fig. 10.*

SYNON.: *Leskea varia* Hedwig, Spec. Musc. 216. *pl. 53. f. 15–20.* 1801.— Bridel, Spec. Musc. **2**: 71. 1812. Mant. Musc. 146. 1819.— Schwægrichen, Spec. Musc. Suppl. I. **2**: 174. 1816.

Hypnum varium Palisot de Beauvois, Prodr. 72. 1805.

Hypnum orthocladon Bridel, Spec. Musc. **2**: 241. 1812. Mant. Musc. 182. 1819. Bry. univ. **2**: 537. 1827.— Schwægrichen, Spec. Musc. Suppl. I. **2**: 262. 1816.— Sullivant, Musc. and Hepat. of the U. S. 78. 1856. Icon. Musc. 199. *pl. 122.* 1864.— Lesquereux & James, Man. Moss. of N. Amer. 374. 1884.— Not of Palisot de Beauvois.

Hypnum debile Bridel, Spec. Musc. **2**: 250. 1812.

Hypnum (*Stereodon*) *varius* Bridel, Bry. univ. **2**: 652. 1827.

Hypnum serpens β. *varium* C. Mueller, Syn. Musc. Frond. **2**: 412. 1851.

Amblystegium radicale Bruch & Schimper, Bry. Eur. Ambly. 10. *pl. 4.* 1853.— Schimper, Syn. Musc. Eur. (1st ed.) 592. 1860. (2d ed.) 711. 1876. — Milde, Bry. Siles. 324. 1869.— De Notaris, Epil. Bry. Ital. 154. 1869.— Hobkirk, Syn. (2d ed.) 213. 1884.

Hypnum radicale Wilson, Bry. Brit. 363. *pl. 25.* 1855.— Sullivant, Musc. and Hepat. of the U. S. 78. 1856.— Berkeley, Handb. Brit. Moss. 97. 1863.— Hobkirk, Syn. 164. 1873.— Boulay, Musc. Fr. 73. 1884.— Lesquereux & James, Man. Moss. of N. Amer. 373. 1884.— Not of Palisot de Beauvois.

Stereodon varius Mitten, Jour. Linn. Soc. **8**: 43. 1864.

Amblystegium varium Lindberg, Musc. Scand. 32. 1872.— R. du Buysson Étud. gen. Ambly. 1883.— Macoun & Kindberg, Cat. Can. Pl. 6: 219. 1892.

— Husnot, Musc. Gall. 359. *pl. 103*. 1893.— Dixon & Jameson, Stud. Handb. 443. 1896.— Braithwaite, Brit. Moss Fl. 3 : 22. *pl. 88*. 1896.

Amblystegium varium var. *lesquereuxii* Renauld & Cardot, Flora Miquelonense 53. 1888.

Amblystegium orthocladon Macoun & Kindberg, Cat. Can. Pl. 6 : 219 1892.

Amblystegium porphyrrhizum Macoun & Kindberg, Cat. Can. Pl. 6 : 219. 1892.

EXSICCATI: *Hypnum radicale* Sullivant & Lesquereux, Musc. Bor. Amer. (1st ed.) 346. (2d ed.) 524.

Hypnum orthocladon Sullivant & Lesquereux, Musc. Bor. Amer. (1st ed.) 347. (2d ed.) 526.

Amblystegium serpens var. *radicale* Austin, Musc. App. 376.

Amblystegium serpens var. *orthocladon* Austin, Musc. App. 379.

Hypnum varium Macoun, Can. Musc. 320.

Hypnum porphyrrhizum Macoun, Can. Musc. 319 (Herb. Wis.).

TYPE in Herb. Hedwig.

Gametophyte bisexual, of *medium size or larger*, forming extensive loose or closely crowded tufts, tufts sometimes as much as 3^{cm} deep, variable in color, bright green, dull dark green or pale yellowish green: stems 150 to 325μ in diameter, 2 to 5^{cm} long, obscurely angled, prostrate, abundantly branched; central strand 8.5 to 35μ in diameter, of six to twenty-five rows of cells; cortex of two to four layers of cells 6 to 18μ in diameter; cells of ground tissue ranging from 17 to 30μ; branches stout or slender, 1 to 3^{cm} long, erect or ascending, flexuous, straight, or having the tips incurved, commonly crowded: leaves very variable in size and shape, lanceolate, *ovate lanceolate to broadly cordate ovate*, generally attaining greatest width in basal sixth, commonly gradually long acuminate, point usually slender, straight or slightly curved, margin entire or (in forms) denticulate above, flat or concave, costate, *costa extending to the apex or well into the base of the acumen*, one fifth to one fourth the leaf base at line of insertion; average leaves 500μ wide by 1200μ long, varying in width from 280 to 575μ and in length from 800 to 1400μ, both larger and smaller forms ocurring, spreading or somewhat appressed in both moist and dry conditions; leaf cells parenchymatous at base, prosenchy-

matous above, commonly regular, occasionally irregular, usually the one or two basal rows of cells somewhat larger than those above, 10 to 18μ wide by 25 to 40μ long, alar cells above these short oblong, quadrate or occasionally slightly transversely elongated, 10 to 15μ wide by 8.5 to 17μ long, in the costal region usually short rectangular, in the middle and apical regions cells hexagonal or the marginal row frequently short rhomboidal, middle leaf cells 9.5μ wide by 35μ long, varying in width from 8 to 13μ and in length from 25 to 48μ, apical cells 10.3μ wide by 34μ long, ranging from 9 to 12μ wide and from 25 to 44μ long; outer perichætial leaves triangular ovate, inner oblong, abruptly short acuminate, all strongly costate, costa excurrent, strict, or the outer spreading, serrulate or entire in the upper lamina.

Sporophyte small to large, 1 to 4^{cm} long: seta reddish at base, pale yellow above, or dark throughout, stout, 165 to 265μ in diameter; cortex of two to three layers of cells 6.4 to 14μ in diameter; central strand well differentiated, 20 to 36μ of eighteen to twenty-five rows of cells, cells of ground tissue 13 to 21.5 in diameter; capsule 1.5 to 6^{mm} long, cylindric, asymmetric, upright to horizontal, almost straight to strongly arcuate, more or less contracted under the mouth when dry, pale yellowish green at maturity, becoming chestnut brown with age; cells of exothecium parenchymatous on the concave side, 32μ wide by 51.4μ long, varying in width from 15 to 47μ and in length from 30 to 90μ, prosenchymatous on the convex side, 27μ wide by 70μ long, ranging from 13 to 42μ wide and from 35 to 120μ long, cell walls 3 to 5μ thick, two to six rows of cells under the peristome hexagonal isodiametric or transversely elongated, 18 to 35μ in diameter; stomata fifteen to thirty to the capsule, scattered, 32μ wide by 43μ long; collum variable, one fourth to one half the length of the sporangium; teeth of peristome cinnamon brown or yellow, paler above, lanceoate, acuminate, serrulate, margined, margin broadest in the middle region, transversely striate on the back in the lower three fifths, sparsely papillose above; endostome pale, finely and densely papillose

throughout, membrane one half the length of the segments; the latter lanceolate, carinate, open along the keel between the articulations, rarely gaping; cilia two to four, slender, equaling the segments, nodose to imperfectly appendiculate; operculum obliquely apiculate from a high convex or conic base, usually as broad as the capsule; annulus of two to three rows of cells: spores light brown, minutely papillose, 13 to 21μ in diameter: calyptra equaling the capsule or shorter, split half its length.

Hab.: On the ground, on decaying wood, at the bases of trees or occasionally on rocks, in moist or wet shady places. Type locality Lancaster, Pennsylvania.

Europe, North and tropical America: throughout southern Canada and the United States. Very common and widely distributed.

With the exception of *A. riparium*, the most variable of all species found in America; the smaller forms easily confused with *A. serpens*, while occasionally the more robust forms approach very nearly to *A. kochii* in the habit of growth and shape of leaf. Here as with *A. serpens*, while there is wide variation there are no forms of sufficient constancy to entitle them to varietal rank. The large form with erect straight branches commonly known as *A. orthocladon* perhaps is the most constant of all the forms, but I have not been able to call it anything more than a form.

AMBLYSTEGIUM IRRIGUUM (Wils.) Bruch & Schimp. *Plate XII. fig. 1.*

SYNON.: *Hypnum fluviatile.* Many authors prior to 1854. Not of Swartz.

Hypnum irriguum Wilson, Bryolog. Brit. 361. *pl. 25.* 1855.—Berkeley, Handb. Brit. Moss. 97. 1863.—Hobkirk, Syn. 164. 1873.—Boulay, Musc. Fr. 72. 1884.—Lesquereux & James, Man. Moss. N. Amer. 374. 1884.

Amblystegium irriguum Bruch & Schimper, Bry. Eur. Ambly. 11 (under the name *A. fluviatile, pl. 5.* 1853.—Schimper, Syn. Musc. Eur. (1st ed.) 594. 1860. (2d ed.) 712. 1876.—Milde, Bry. Siles. 326. 1869.—De Notaris, Epil. Bry. Ital. 152. 1869.—Hartmann, Skand. Fl. (10th ed.) 20. 1871.—Lindberg, Musc. Scand. 32. 1879.—Hobkirk, Syn. (2nd ed.) 213. 1884.—Macoun and Kindberg, Cat. Can. Pl. 6:220. 1892.—Husnot, Musc. Gall. 360. *pl. 103.* 1894.—Dixon & Jameson, Stud. Handb. 444. *pl. 56.* 1896.—Braithwaite, Brit. Moss Fl. 3:21. *pl. 88.* 1896.

Amblystegium fluviatile var. *irriguum* R. du Buysson, Ess. Anal. gen. Ambly. 1883.

EXSICCATI: *Amblystegium serpens* var. *irriguum* Austin, Musc. App. 375.

TYPE in Herb. Wilson.

Gametophyte bisexual, of medium size or larger, closely cespitose, *usually dark green*, sometimes light green or yellowish or brown: *stems rigid*, prostrate or ascending, irregularly subpinnately branched, 2^{cm} to 6^{cm} long, 200 to 350 μ in diameter, cylindrical; central strand well differentiated, 25 to 40 μ in diameter of sixteen to twenty-five rows of cells; cortex of three or four layers of cells, 6.5 to 13 μ in diameter, walls strongly thickened, cells of ground tissue abruptly enlarged just within the cortex and increasing uniformly toward the center of the stem, reaching the greatest size near the central strand, 18 to 38.5 μ in diameter; branches in the looser forms creeping or ascending, erect or ascending in the compactly growing patches, 0.5 to 3^{cm} long: leaves deltoid ovate, or ovate lanceolate, 400 μ wide by 1000 μ long, in large forms reaching 1500 μ long, more or less cordate and decurrent, reaching greatest width in basal fifth, occasionally just above the line of insertion, acuminate, subserrulate, open-erect or spreading, *frequently subfalcate and subsecund*, costate to near the apex of the *usually long and slender acumen*, *costa strong*, *thick*, one-fifth to one-third the entire leaf base at line of insertion, 60 to 85 μ wide, *tapering uniformly to the tip of the leaf*, *biconvex*, in the dry condition leaf points slightly incurved, otherwise as in the moist condition; leaf cells parenchymatous at base, prosenchymatous above, *usually one row of cells across the base of the leaf much enlarged*, 13 to 21.5 μ wide by 30 to 55 μ long, cells immediately above these *short-oblong*, 13 μ wide by 21.5 μ long, narrowing rapidly and becoming prosenchymatous at the greatest width of leaf, the cells in the alar regions (excluding the row of large cells at base) slightly transversely elongated, quadrate or short oblong, soon becoming oblong or rhomboidal above, 12 to 16 μ wide by 9 to 20 μ long, cells in the middle and upper parts of the leaf rhomboidal or hexagonal, the former 8.6 μ wide by 31.5 μ long, occasionally somewhat narrower, 6 μ wide by 40 μ long, the latter 9.5 μ wide by 43 μ long; perichætial

leaves ovate lanceolate to oblong lanceolate, erect, acuminate, costate, costa excurrent.

Sporophyte usually large, 1.5 to 4^{cm} long: seta stout, 200 to 280μ in diameter, dark purple below, reddish above; central strand equaling in diameter the largest cells of the ground tissue, 30μ, composed of ten to eighteen rows of cells; cortex of two to three layers of cells 8.6 to 12.8μ in diameter; cells of ground tissue varying from 18.5 to 30μ in diameter, the largest found about midway between the cortex and the central strand: capsule oblong or cylindrical, asymmetric, rarely almost symmetric, slightly inclined to strongly incurved, suberect to horizontal, generally strongly constricted under the mouth when dry; collum one-third the length of the sporangium; cells of exothecium mostly parenchymatous, more or less prosenchymatous on the convex side, cells on the convex side varying from 15 to 55μ wide and from 55 to 165μ long, averaging 30μ wide by 120μ long, cells of concave side 22 to 60μ in width and 43 to 128μ in length, averaging 38μ wide by 76μ long, walls 2 to 4μ thick, five to seven rows of cells under the mouth of the capsule isodiametric, or the three next the annulus slightly transversely elongated, 20 to 40μ in diameter; stomata thirty to forty to the capsule, 44μ wide by 58μ long, scattered; peristome teeth lanceolate, orange below, hyaline above, bordered, border narrow at base, becoming broader above, teeth entire or slightly serrulate above, transversely striate in the lower half or two thirds, papillose above; endostome shorter than the teeth, hyaline, papillose throughout, membrane three-fourths the length of the segments, the latter lanceolate to ovate-lanceolate, carinate, open along the keel between the articulations, not gaping, cilia two to four, equaling the segments or shorter, nodose; operculum apiculate from a highly convex or conic base; annulus broad, of two to three rows of cells: spores yellowish green, coarsely tuberculate, 15 to 21μ in diameter: calyptra two-thirds the length of the capsule, split half its length.

HAB.: Along the margins of brooks, ponds, lakes and other similar places on the ground and on stones. Type locality England.

Europe, Asia, Africa, and North America: New England, New York, New Jersey, Ohio, West Virginia, Wisconsin, Montana, Minnesota and Ontario. Not uncommon.

Long confused with *A. fluviatile*, from which plant it may be known by its long acuminate leaves, with a costa tapering gradually and uniformly from the base to the tip of the leaf, and by the leaf cells, which, above the basal row, are commonly uniformly smaller. This is especially true for the basal third of the leaf. The general habit of the two plants will aid in separating them, *A. irriguum* having a harsh and rigid appearance, while *A. fluviatile* is soft and pliable. *A. irriguum* may be distinguished from *Hypnum filicinum* by the broad triangular ovate leaves of the latter, having a distinctly serrate margin in the upper part and having the cells in the alar regions inflated.

AMBLYSTEGIUM IRRIGUUM SPINIFOLIUM Schimp. *Plate XII. fig. 1.*

SYNON.:[1] *Hypnum fallax* Bridel, Musc. Recent. 3[2]: 66. *pl. 2. f. 1.* 1801. (fide Schimper, and many later authors.)

Hypnum filicinum var. *fallax* Hooker & Taylor, Muscologia Brittanica, 109.— Bridel, Bry. Univ. **2**: 531. 1827.

Hypnum fluviatile C. Mueller, Syn. Musc. Frond. **2**: 420. 1851.

Amblystegium irriguum var. *fallax* Schimper, Syn. Musc. Eur. (1st ed.) 594. 1860.

Amblystegium irriguum var. *spinifolium* Schimper, Syn. Musc. Eur. (2d ed.) 713. 1876.

Amblystegium fallax Lindberg, Musc. Scand. 32. 1879.—Braithwaite, Brit. Moss. Fl. **3**: 19. *pl. 88.* 1896.

Amblystegium filicinum var. *fallax* Lindberg, Musc. Scand. 35. 1879.

Amblystegium fluviatile var. *irriguum*, forma *spinifolium* R. du Buysson, Ess. Anal. gen. Ambly. 1883.

Amblystegium vallis-clausæ var. *spinifolium* Husnot, Musc. Gall. 361. 1894.

TYPE in Herb. Bridel.

Gametophyte more robust than in the species; stems longer, 3 to 12[cm], more loosely branching; leaves generally *longer and narrower, with a long excurrent slender-pointed costa*, 900 to 1800μ long by 200 to 585μ wide; leaf cells at least in the upper portions of the leaf correspondingly elongated, 6 to 9μ wide by 40 to 70μ long.

[1] No attempt has been made to give a complete synonomy, owing to the confusion prior to the time of Schimper.

Sporophyte as in the species.

HAB.: In very wet places, either floating or on substratum kept constantly wet by spray or falling water. It appears to be of common occurrence in Europe, but is seldom met with in N. America. Type locality Europe.

Europe, Asia, Africa, and North America: New Jersey and Pennsylvania.

This form has been confused with the submerged form of *A. noterophilum* by most bryologists who have worked with American mosses. The latter is usually a much larger plant, having the body of the leaf ovate or broader, generally not acuminate except by the very strong long excurrent costa, which is twice as wide as that found in *A. irriguum spinifolium*; often appearing much wider, owing to the presence of a second layer of cells in the costal region of the lamina.

AMBLYSTEGIUM NOTEROPHILUM (Sulliv.) Holzinger. *Plate XII. fig. 3.*

SYNON.: *Hypnum noterophilum* Sullivant, Musc. and Hepat. of U. S. 78. 1856.

Hypnum fluviatile James, Proc. Academy Nat. Sciences of Philadelphia 1855: 447. 1855.

Hypnum irriguum var. *spinifolium* Lesquereux & James, Man. Moss. N. Amer. 374. 1884.—Macoun & Kindberg, Cat. Can. Pl. 6: 220. 1892.

Amblystegium noterophilum Holzinger, Bull. Geol. and Nat. Hist. Surv. Minn. 9: 293. Nov. 1895.

EXSICCATI: *Hypnum noterophilum* Sulliv. & Lesq., Musc. Bot. Amer. (1st ed.) 348.

Amblystegium serpens irriguum noterophilum Austin, Musc. App. 385.

TYPE in Herb. Sullivant, Cambridge.

Gametophyte bisexual, of medium or large size, varying from bright yellow green to a very dark dull green, rarely bronze in the new shoots of submerged plants, sometimes having a vitreous appearance, *harsh and rigid*, when growing out of water in close moderately thick tufts, in the water forming crowded floating masses: *stems rigid*, prostrate or ascending when not submerged, otherwise floating, profusely and irregularly branched, 2 to 15^{cm} long, 200 to 400μ in diameter, cylindrical; cortex of three to

four layers of incrassate cells 4 to 17 μ in diameter; central strand well differentiated, 30 to 45 μ in diameter, of twelve to twenty-one rows of cells; branches in terrestrial form ascending, 1 to 2.5^{cm} long, those of the submerged form 3 to 8^{cm} long bearing few short (1^{cm}) branchlets, in all cases densely leafy, the stems and branches of the submerged plants *at length naked or covered with the very stout excurrent costæ of the leaves*, due to the maceration of the leaf blade: leaves varying from *broadly triangular cordate ovate* in land form to long lanceolate in submerged form, *generally abruptly short acuminate by the excurrent costa*, straight or with the point moderately curved, in water form 550 μ wide by 1350 μ long, varying from 450 to 700 μ wide and from 1050 to 1500 μ long, extremely large plants having leaves 900 μ wide by 2200 μ long, in terrestrial plants the leaves proportionately wider, 500 μ wide by 850 μ long, rarely reaching 450 μ wide by 600 μ long, *strongly costate*, *costa commonly excurrent forming a very thick rather blunt cusp*, sometimes in the land form vanishing in the tip, one-sixth to one-third the leaf base at line of insertion, 65 to 225 μ wide, plano-convex at base, double convex above to the tip, there sometimes becoming again flattened on the upper side; leaf blade *very commonly of two layers of cells in the basal sixth and along the costa well toward the tip*, margin *usually entire*, rarely slightly serrulate in the upper part of blade, greatest width of leaf attained in the basal sixth, open or erect spreading in land plants, slightly spreading or strict in submerged form; leaf cells parenchymatous at base, prosenchymatous in the middle and upper lamina, or mixed at the upper end of the blade, in the alar and apical regions in the extreme long and short forms cells essentially the same in size, those in the middle portion of the long leaves proportionately longer, in average leaves alar cells 14 μ wide by 22 μ long, varying from 12 to 17 μ wide and from 19 to 23 μ long, the middle leaf cells varying from 9 to 11 μ wide and from 38 to 45 μ long, averaging 10.5 μ wide by 43.4 μ long, these cells varying in the extreme forms from 9 by 18 μ to 12 by 90 μ, cells in upper lamina beside the costa 10 μ wide by 28 μ long, ranging from 9 to 11 μ in width and from

25 to 32 μ long; perichætial leaves not essentially different from the others in shape and size, strongly costate, costa excurrent, cells *incrassate*, leaves all strict.

Sporophyte of medium size, 1.5 to 2.5^{cm} long, produced only on plants not submerged: seta stout, purple at base, paler almost yellow in upper third, 270 to 330 μ in diameter; cortex of three (occasionally four) layers of cells, these 6 to 15 μ in diameter; central strand 35 to 50 μ in diameter, composed of twenty to fifty rows of cells; cells of ground tissue 18 to 35 μ in diameter: capsule purple or dark chestnut brown, large, 2 to 4.5^{mm} long, cylindric or widening gradually from the base of the collum to the lid, asymmetric, incurved from an erect base, gradually cernuous, much shrunken in all parts and constricted under the mouth in drying; collum large, one-half to two-thirds the length of the sporangium; cells of the exothecium parenchymatous for the most part throughout, sometimes more or less prosenchymatous on the convex side, cells on the concave side 24 μ wide by 33 μ long, varying in width from 17 to 35 μ and in length from 21 to 50 μ, cells of convex side 18 μ wide by 55 μ long, ranging from 15 to 30 μ wide and from 25.5 to 77 μ long; cell walls 3 to 6 μ thick; cells under the peristome slightly smaller, two to four rows 8.5 to 30 μ long by 17 to 38.5 μ wide; stomata *very numerous, ninety to two hundred* to the capsule, *crowded in a comparatively narrow band and often clustered, two to seven adjoining*, commonly *as broad as long or broader*, average 37.5 μ wide by 36 μ long; teeth of peristome yellow at base yellowish brown above to the slender hyaline tip, lanceolate, acuminate, irregularly serrulate in upper third, narrowly bordered, transversely striate on the back to the middle or beyond, coarsely and irregularly papillose in upper third; endostome pale and faintly papillose throughout, shorter than the teeth, membrane two-thirds to three-fourths the length of the segments, the latter lanceolate, carinate, open along the keel between the articulations or with only occasional perforations along the keel, cilia one to three, slender, weak, nodose, shorter than the segments; operculum apiculate from a highly convex base: spores finely

papillose, 16 to 30 μ in diameter: calyptra one-half to three-fourths the length of the capsule, split one-third its length, falling before the spores are mature.

HAB.: In springs and at their margins (usually calcareous), and the streams running from them. Type locality Franklin county, Pennsylvania.

North America: Pennsylvania, New York, Illinois, Michigan, Wisconsin, Minnesota, Montana, Ontario. Local.

A plant that appears to be related to both *A. irriguum* and *A. fluviatile* with both of which it has been associated, especially the large floating form. Doubtless the absence of the sporophyte from most material and the exclusive (?) use of the water form for study have led to this confusion.

AMBLYSTEGIUM FLUVIATILE (Swartz) Br. & Sch. *Plate XII. fig. 2.*

SYNON.: *Hypnum fluviatile* Swartz, Musc. Frond. Suec. 63. 1799.—Hedwig, Spec. Musc. 277. *pl. 71. fig. 4.* 1801.—Palisot de Beauvois, Prodr. 1805.—Weber & Mohr, Bot. Tasch. 303. 1807.—Schwægrichen, Spec. Musc. Suppl. 1. 2 : 263. 1816.—Hartmann, Skand. Fl. (5th ed.) 333. 1849.—Wilson, Bry. Brit. 359. *pl. 55.* 1855.—Berkeley, Handb. Brit. Moss. 98. 1863.—Hobkirk, Syn. 164. 1873.—Lesquereux & James, Man. Moss. of N. Amer. 375. 1884.

Hypnum orthocladon Palisot de Beauvois, Prodr. 67. 1805.

Hypnum palustre fluviatile Wahtenberg, Fl. Suec. (2d ed.) 732. 1833.

Amblystegium fluviatile Bruch & Schimper, Bry. Eur. Ambly. Suppl. 1. 1. *pl. 1.* 1854.—Schimper, Syn. Musc. Eur. (1st ed.) 594. 1860. (2d ed.) 713. 1876.—Milde, Bry. Siles. 326. 1869.—Hartmann, Skand. Fl. (10th ed.) 20. 1871.—Lindberg, Musc. Skand. 32. 1879.—R. duBuysson, Ess. Anal. gen. Ambly. 12. 1883.—Hobkirk, Syn. (2d ed.) 213. 1884.—Macoun & Kindberg, Cat. Can. Pl. 6 : 220. 1892.—Husnot, Musc. Gall. 360. 1894.—Dixon & Jameson, Stud. Handb. 445. *pl. 56.* 1896.—Braithwaite, Brit. Moss Fl. 3 : 22. *pl. 88.* 1896.

Hypnum irriguum fluviatile Boulay, Musc. Fr. 73. 1884.

EXSICCATI: *Amblystegium fluviatile* Austin, Musc. App. 38.—Macoun, Can. Musc. 446.

TYPE in herb. Swartz, Stockholm.

Gametophyte bisexual, *soft and pliant*, of medium or large size, when not submerged on a solid substratum in dense thick tufts, when submerged, having a looser habit, sometimes considerably elongated and floating, varying in color from a dark dirty green to

light yellowish green, *usually with a vitreous or metallic luster:* stems prostrate when not submerged, ascending or floating when in the water, abundantly branched, sometimes sparingly so in water, *defoliate in the older portions* by the maceration of the leaves, 3 to 8^{cm} long, 180 to 210μ in diameter, scarcely angled; *central strand rudimentary or none*, when present of three to six rows of cells; cortex of two to four layers of cells 8.6 to 13μ in diameter, cells of ground tissue 13 to 20μ in diameter, abruptly larger than the cells of the cortex; branches simple, inclined or suberect, 1.5 to 4^{cm} long in terrestrial forms, longer in submerged plants, 3 to 7^{cm}, often with tips slightly hooked: leaves ovate, ovate lanceolate or oblong lanceolate, average leaves 650 to 700μ wide and 1500 to 1600μ long, concave, *very slightly or not at all acuminate*, point *usually blunt, entire*, strongly costate, costa plano-convex in the basal fourth of the leaf, double convex to almost cylindrical above, one-sixth to one-fourth the leaf base at the line of insertion, 85 to 120μ in width, tapering somewhat to the tip of the leaf, *here 45 to 60μ in width, flattening and disappearing abruptly within the point, strictly erect* or slightly spreading, occasionally subsecund, slightly incurved when dry, especially in terrestrial forms, not decurrent; leaf cells parenchymatous in lower half, at base *large*, 13 to 21.5μ wide by 30 to 70μ long, averaging across the base *16μ wide by 40μ long;* passing gradually into cells above varying from linear rectangular to linear rhomboidal or shorter, 10.5μ wide by 3 to 7μ long; these again passing gradually into cells regularly hexagonal, 10.5μ wide by 38μ long, cells at apex 15μ wide by 30μ long, alar cells rarely noticeably differentiated; perichætial leaves ovate or ovate-lanceolate, acute or sometimes short acuminate, costate to the erect apex, cells linear or nearly so, entire or denticulate at apex.

Sporophyte medium to large, 1.5 to 3.5^{cm} long: seta 180 to 240μ in diameter, purple at base, gradually passing to light brown or yellow above; central strand well developed, 25 to 45μ in diameter, of sixteen to thirty-five rows of cells; cortex of two to three layers of cells 6 to 12μ in diameter; cells of ground tissue abruptly larger than cortical cells, 13 to 20μ, larg-

est cells midway between cortex and central strand: capsule pale at maturity before dehiscence, usually brick red to chestnut brown when empty, 2 to 5^{mm} long, subcylindric or gradually widening to the mouth, incurved from an erect base to arcuate, more or less constricted below the mouth when dry; collum one-third to one-half the length of the sporangium; cells of exothecium parenchymatous on the concave side, 25μ wide by 47μ long, varying in width from 17 to 43μ, and in length from 21 to 77μ, longer on the convex side and more or less prosenchymatous, especially in the lower half of the sporangium, 25.5μ wide by 53.5μ long, ranging from 15 to 35μ wide and from 25 to 120μ long, five to seven rows of cells under the mouth isodiametric, 17 to 25.5μ in diameter, usually about two rows next the annulus transversely elongated, 8.5 to 15μ long by 17 to 30μ wide; cell walls 3 to 4μ thick; stomata numerous, *twenty-five to eighty* to the capsule, *38.5μ wide by 47μ long, scattered*; peristome teeth orange or reddish-brown below, margined, margin narrow at base widening above into the hyaline tip, serrulate in upper third, transversely striate on the back in the lower half, papillose above, occasionally having the striæ oblique or irregular in small areas near the middle; endostome pale, scarcely equaling the teeth, papillose throughout, membrane three-fourths the length of the segments, the latter lanceolate, carinate, split along the keel between the articulations, not gaping, cilia two or three, shorter than the segments, nodulose or subappendiculate; operculum conic and acute or apiculate from a highly convex base; annulus broad, of two to three rows of cells: spores finely tuberculate, 16 to 26μ; calyptra small, one-fourth to one-half the length of the capsule, split one-third its length.

HAB.: On rocks and earth in and along streams. Type locality Sweden.

Europe, and North America: New Brunswick, Newfoundland, Quebec, Ontario, New York, New Jersey, Ohio, Michigan, and Wisconsin.

The leaves of this species, usually not acuminate, with entire margin, broad blunt apex and strong costa vanishing in the tip, are generally suf-

ficient to enable one to distinguish it from its near relatives *A. irriguum* and *A. noterophilum*. Its larger leaf cells in the basal half will assist in separating it from the first, while the second generally has a much wider and generally excurrent costa, and two layers of cells in the lamina at the base and along the costa for half its length or more.

AMBLYSTEGIUM LESCURII (Sulliv.) Aust. *Plate XI. fig. 9.*

SYNON.: *Hypnum lescurii* Sullivant, Musc. and Hepat. of U. S. 79. 1856. Icon. Musc. 203. *pl. 124.* 1864.—Lesquereux & James, Man. Moss. of N. Amer. 376. 1884.

EXSICCATI: *Hypnum lescurii* Sulliv. & Lesq., Musc. Bor. Amer. (1st ed.) 350 (2d ed.) 529.

Amblystegium lescurii Austin, Musc. App. 371. 1870.

TYPE in herb. Sullivant, Harvard University.

Gametophyte bisexual, of medium size, loosely cespitose, *yellowish to dark green, ferruginous within the tufts with age:* stems prostrate, *generally defoliate in older parts*, profusely branched, *thick, rigid*, 160 to 210 μ in diameter, 2 to 6^{cm} long, obscurely angled; central strand small, 6 to 10 μ in diameter, composed of five to ten rows of cells; cortex of three to five layers of small incrassate cells, 6.5 to 13 μ in diameter, well differentiated from ground tissue, the cells of the latter *abruptly larger*, 18 to 26 μ in diameter; branches erect with very few branchlets, 1 to 3^{cm} long: *leaves ovate to very broadly ovate*, occasionally as broad as long, 360 μ wide by 750 μ long, reaching in some instances 1500 μ long, concave, abruptly *short* acuminate, *bordered, border of two layers of linear vermicular incrassate cells*, three to five cells wide, denticulate at apex, sometimes sparingly so to near the base, costate, costa thick, bi-convex in section, 40 to 55 μ wide, extending to the apex of the leaf, here becoming flattened and *blending with the thickened border*, when moist spreading in all directions, rarely subsecund, in the dry state the leaf tips more or less inflexed from the open-spreading bases; leaf cells parenchymatous, walls thick in all parts of the leaf, in the alar region usually a few short oval cells, excluding these alar cells long hexagonal or rhomboidal, 9 μ wide by 25 μ long, ranging in width from 6.5 to 13 μ and in length from 15 to 32 μ, in the middle border region cells 5.6 μ wide by 30.8 μ long, vary-

ing from 4.5 to 8.5 μ in width and from 24 to 39 μ in length, in the middle costal region cells much shorter and oval-hexagonal, 7.5 μ wide by 18 μ long, midway between border and costa the cells still shorter, at the apex the marginal cells oval or subrhomboidal, 9 μ wide by 17 μ long, varying from 8 to 10 μ wide and from 14 to 20 μ long; perichætial leaves ovate lanceolate to lanceolate, the outer gradually acuminate, all erect, strongly costate, costa long excurrent.

Sporophyte medium, 1 to 3^{cm} long: seta stout, 250 to 300 μ in diameter, dark purple below, yellow above; central strand well developed, 30 to 38 μ in diameter, of thirty to forty rows of cells, walls of cells strongly thickened for this tissue; cortex of three to four layers of cells, 4 to 13 μ, passing gradually into ground tissue; cells of this tissue ranging from 13 to 23 μ: capsule oblong, unsymmetric, cernuous, with short collum, becomimg dark brick red with age, not constricted under the mouth when dry or only moderately so; cells of exothecium parenchymatous on concave side, 23 μ wide by 32 μ long, ranging in width from 20 to 26 μ, and in length from 17 to 47 μ, prosenchymatous on convex side, 20 μ wide by 40 μ long, varying from 13 to 23 μ wide and from 30 to 65 μ long; cell walls 2 to 3 μ thick; three to five rows of isodiametric, quadrate or hexagonal cells under the mouth, 15 to 22 μ in diameter, walls 4 μ thick; stomata ten to twenty-five to the capsule, 30.5 μ wide by 34.5 μ long, scattered; peristome teeth lanceolate, golden yellow with a broad paler margin, serrate in the upper half, transversely striate on the back to near the middle, above this point dotted with scattered papillæ among the striæ, the latter soon being replaced above by densely crowded ciliate papillæ; endostome pale yellow, equaling the teeth; membrane two-thirds the length of the segments, the latter lanceolate, carinate, split, but not widely open along the keel between the articulations, finely papillose, cilia one to three, stout, shorter than the segments, nodulose; operculum apiculate from a convex or conic base; annulus broad, of two to three rows of cells: calyptra equaling capsule, split one-third its length.

HAB.: On wet rocks, usually in mountain streams. Type locality Tallulah Falls, Georgia.

North America: Georgia, Virginia, West Virginia, Pennsylvania, New York, New Jersey, Maine. Rare or local.

The most distinctly characterized of all our Amblystegia. No difficulty need be experienced in separating it from other species if one of its leaves is at hand. The leaf border is evident under moderate magnification.

AMBLYSTEGIUM RIPARIUM (Hedw.) Br. & Sch. *Plate XIII. fig. 1.*

SYNON.: *Hypnum riparium* Hedwig, Musc. Frond. **4**: 7 *pl. 3.* 1797. Spec. Musc. 241. 1801.—Abbot, Flora Bedfordiensis 250. 1798.—Hull, British Flora **2**: 273. 1799.—Swartz, Musc. Suec. 1799.—Bridel, Musc. Recent. **3**: 176. 1801. Spec. Musc. **2**: 112. 1812. Mant. Musc. 157. 1819. Bry. Univ. **2**: 412. 1827.—Smith, Fl. Brit. 1292. 1804. Eng. Bot. *pl. 2060.*—Turner Musc. Hib. 152. 1804.—Palisot de Beauvois, Prodr. 69. 1805.—Schultz, Fl. Starg. 324. 1806.—Weber & Mohr, Bot. Tasch. 331. 1807.—Voit, Muscorum Herbipolitano 111. 1812.—Schwægrichen, Spec. Musc. Suppl. 1. **2**: 194. 1816.—Hooker & Taylor, Musc. Brit. 92. 1818.—Hooker Fl. Scot. **2**: 141. 1820.—Funck, Moost. 56. *pl. 37.* 1821.—Gray. Nat. Arr. Brit. Pl. **1**: 752. 1821.—Huebener, Musc. Germ. 619. 1833.—DeNotaris, Syllab. 4. 1838.—Rabenhorst, Deutschl. Kr. Fl. **2**^{3}: 293. 1848.—C. Mueller, Syn. Musc. Frond. **2**: 321. 1851. Deutchl. Moos. 427. 1853.—Wilson Bry. Brit. 364. 1855.—Sullivant, Musc. and Hepat. U. S. 79. 1856.—Berkeley, Handb. Brit. Moss. 98. 1863.—Hobkirk, Syn. 164. 1873.—Boulay, Musc. Fr. 76. 1884.—Lesquereux & James, Man. Moss. N. Amer. 376. 1884.—Dixon & Jameson, Stud. Handb. 452. 1896.

Amblysteginm riparium Bruch & Schimper, Bry. Eur. Ambly. 14. *pl. 8.* 1853.—Schimper, Syn. Musc. Eur. (1st ed.) 597. 1860. (2d ed.) 717. 1876.—Milde, Bry. Siles. 328. 1869.—De Notaris, Epil. Bry. Ital. 146. 1869.—Hartmann, Skand. Fl. (10th ed.) 19. 1871.—R. du Buysson, Ess. anal. gen. Ambly. 1883.—Hobkirk, Syn. (2d ed.) 213. 1884.—Macoun & Kindberg. Cat. Can. Pl. 6: 221. 1892.—Husnot, Musc. Gall. 363. *pl. 104.* 1893.—Braithwaite, Brit. Moss. Fl. **3**: 29. *pl. 89.* 1896.

Stereodon riparium Mitten, Jour. Linn Soc. **8**: 43. 1864.

EXSICCATI: *Hypnum riparium* Sulliv. & Lesq., Musc. Bor. Amer. (1st ed.) 349. (2d ed.) 527.—Macoun, Can. Musc. 325.

TYPE probably not in existence. The plant was known to botanical writers prior to the time of Dillenius, probably early in the eighteenth century.

Gametophyte bisexual, medium *to very large, in extensive loose tufts*, bright green to yellowish green, occasionally of a decided yellow or bronze: stems *long, flaccid, prostrate* or floating, spar-

ingly branched, 5 to 20^{cm} long, 250 to 400μ in diameter, cylindrical; central strand well differentiated though small, 20 to 27μ in diameter, of ten to fifteen rows of cells; cortex of two to three layers of cells, usually not well differentiated, cells 8 to 22μ in diameter, those of the ground tissue 17 to 40μ; primary branches few, 2 to 8^{cm} long, prostrate, branchlets short, 1 to 3^{cm}, prostrate: leaves ovate lanceolate to linear lanceolate, long acuminate, terminating in a slender, straight, or curved point, 650μ wide by 2200μ long, ranging in width from 450 to 700μ and in length from 1700 to 2400μ, attaining greatest width in the basal fifth, many ranked, commonly complanate, occasionally equally spreading or subsecund, rarely erect, ordinarily more or less widely spreading, frequently folded or twisted when dry, costate, costa thin, extending through the lower half to three-fourths of the leaf, one-sixth to one-fifth its base at the line of insertion, 50 to 75μ wide, margin ordinarily *very entire*, rarely subserrulate; leaf cells parenchymatous across the base, soon becoming prosenchymatous above, the basal cells quadrate to oblong, the one or two marginal rows narrower and longer, 16μ wide by 36.6μ long, ranging from 13 to 20μ in width and from 20 to 50μ in length; cell walls strongly thickened and *sparsely* pitted, in all parts of the leaf above the basal eighth the cells *long hexagonal to linear*, in the middle region 8.5μ wide by 95μ long, varying in width from 7.8 to 9μ and in length from 85 to 100μ, frequently vermicular, cells of apical region shorter, 9.3μ wide by 34μ long, ranging from 8.8 to 10μ in width and from 28 to 38μ in length; outer perichætial leaves triangular-ovate, spreading from the middle, inner oblong, erect, all abruptly short acuminate and costate to the base of the acumen or nearly so, coarsely and irregularly serrate above or entire.

Sporophyte medium, 1 to 3^{cm} long: seta purple at base, light brown or yellow above, or uniformly pale brown throughout, 170 to 260μ in diameter, cortex of two to three layers of cells, 6.5 to 15μ in diameter; central strand well differentiated, 30 to 36.5μ in diameter, composed of thirty to forty-five rows of cells; cells of ground tissue 9 to 26μ in diameter: capsule short, oval,

1 to 2^{mm} long, pale yellowish green at maturity, sometimes of two colors, pale on the concave side and brown above, becoming a uniform light brown or dark chestnut brown, unsymmetric, from slightly inclined to horizontal, strongly incurved, constricted under the mouth when dry; collum one-fourth to one-third the length of the sporangium; cells of exothecium parenchymatous throughout or more or less prosenchymatous on the convex side, cells on the concave side 43μ wide by 53.5μ long, ranging from 21.5 to 60μ in width and from 30 to 77μ in length, those on the convex side 34.5μ wide by 82.5μ long, ranging in width from 21 to 43μ and in length from 60 to 120μ, cells under the peristome but slightly different, sometimes one or two rows a little smaller and transversely elongated, 17 to 21.5μ long by 17 to 26μ wide; cell walls 2 to 3μ thick; stomata twenty-five to thirty-five to the capsule, scattered, 43μ wide by 52μ long; peristome teeth light brown at base, paler above, hyaline at the points, narrowly margined, serrate in the upper third, transversely striate on the back in the basal three-fifths, with occasional areas near the middle with striæ running obliquely or longitudinally, papillose above, papillæ large; endostome shorter than the teeth, hyaline, papillose throughout, membrane one-half to two-thirds the length of the segments, the latter carinate, frequently not open along the keel except in the upper third, never gaping, cilia one to four, slender, nodose or appendiculate, equaling the segments; operculum rostellate or apiculate from a depressed convex to conic base; annulus broad, of two to three rows of cells: spores finely tuberculate, 13 to 21μ in diameter: calyptra equalling the capsule, split half its length or less.

HAB.: In wet localities, either in stagnant or slow running water, or on the ground, logs, boards, etc.

Type locality England, Thames river. Common and variable everywhere.

This species is probably the most variable of all our Amblystegia though in general habit it is comparatively constant. It is sometimes confused with *Hypnum* (*Campylium*) *polygamum*. The latter plant generally has a different habit; its stems more or less upright, with leaves equally spreading in all directions from near the base.

AMBLYSTEGIUM RIPARIUM FLORIDANUM Ren. & Card. *Plate XIII. fig. 2.*

SYNON.: *Amblystegium riparium* var. *floridanum* Renauld & Cardot, Botanical Gazette **14**: 98. 1889.

Amblystegium floridanum Renauld & Cardot, Musci. Americæ Septentrionalis 58. 1893.

TYPE in herb. Cardot, Stenay, France.

Gametophyte small: stems 1 to 2^{cm} long, sparsely branched: leaves *linear to lanceolate*, 50 to 330μ wide by 800 to 1200μ long; leaf cells about as in the species in all parts.

Sporophyte small, 1^{cm} long; capsule 1 to 1.5^{mm} long.

Hab.: On decaying wood in moist or wet places. Type locality Florida and Louisiana.

North America: Gulf and south Atlanlic states.

Has the general habit and appearance of the species throughout. May be known by its very small size.

AMBLYSTEGIUM RIPARIUM ABBREVIATUM Br. & Sch.

SYNON.: *Amblystegium riparium abbreviatum* Bruch & Schimper, Bry. Eur. Ambly. 14. *pl. 9. f. β. 1* and *2*. 1853.—Schimper, Syn. Musc. Eur. (1st ed.) 598. 1860 (2d ed.) 718. 1876.—De Notaris, Epil. Bry. Ital. 147. 1869.—Husnot, Musc. Gall. 363. 1894.—Braithwaite, Brit. Moss. Fl. **3**: 30. 1896.

Hypnun riparium var. *abbreviatum* Lesquereux & James, Man. Moss. N. Amer. 377.

Gametophyte with stems and branches *short*, the former *1 to 3^{cm} long*, the latter *1^{cm} long:* leaves as in the species except a little smaller in size.

Sporophyte as in medium forms of the species.

Type locality, Europe.—Europe and North America.

Probably this and the preceding variety will have to be omitted when more abundant material can be obtained for study. Found occasionally with the species.

AMBLYSTEGIUM RIPARIUM FLACCIDUM (L. & J.) R. & C.

SYNON.: *Hypnum riparium* var. *flaccidum* Lesquereux & James Man. Moss. N. Amer. 377.

Amblystegium riparium var. *flaccidum* Renauld & Cardot, Musc. Amer. Sept. 58. 1893.

TYPE in herb. James, Harvard University.

Gametophyte very much attenuated: stems long, *filiform*, 10 to 40^{cm} long, sparingly branched; branches correspondingly long: leaves slender, *remote*.

Sporophyte usually much larger than in other forms, 3 to 6^{cm} or more long, not abundant.

HAB.: Growing in the water, generally in shaded places. A common form in N. America with the species.

AMBLYSTEGUM RIPARIUM FLUITANS (L. & J.) R. & C.

SYNON.: *Hypnum riparium* var. *fluitans* Lesquereux & James, Man. Moss. N. Amer. 377.

Amblystegium riparium var. *fluitans* Renauld & Cardot, Musc. Amer. Sept. 58. 1893.

Gametophyte large: stems and branches long, 10 to 20^{cm}, dirty green or yellow: leaves *large*, *800 μ wide by 3200 μ long*, sometimes more than 4000 μ in length and of proportionate width.

Sporophyte rarely produced, not seen by me.

HAB.: Floating in shallow water at margins of streams and from logs, stumps, etc., in the water.

With the species. Not uncommon.

AMBLYSTEGIUM RIPARIUM LONGIFOLIUM (Schultz) Sch. & Buys.

SYNON.: *Hypnum longifolium* Schultz, Fl. Starg. 335. 1806.— Bridel, Spec. Musc. **2**: 114. 1812. Mant. Musc. 158. 1819.

Hypnum riparium longifolium Bridel, Bry. Univ. **2**: 414. 1827.

Amblystegium riparium var. *longifolium* Schimper, Syn. Musc. (1st ed.) 598. 1860. (2d ed.) 718. 1876.— Braithwaite, Brit. Moss. Fl. **3**: 29.

Gametophyte large, yellowish green to bright yellow or bronze: stems moderately elongated, 3 to 8^{cm} long: leaves large, 600 to 700 μ wide by 3500 to 4200 μ long, acuminate, acumen very slender.

Sporophyte unknown to me.

HAB.: Europe, and North America: Vancouver and Washington.

The forms here given as varieties are thought to be the most constant ones and those about which the well nigh numberless others may be satisfactorily grouped.

AMBLYSTEGIUM KOCHII Br. & Sch. *Plate XII. fig. 5.*

SYNON.: *Amblystegium kochii* Bruch & Schimper, Bry. Eur. Ambly. 13. *pl. 6.* 1853.—Schimper, Syn. Musc. Eur. (1st ed.) 596. 1860. (2d ed.) 716. 1876.—Milde, Bry. Siles. 327. 1869.—Hartmann, Skand. Fl. (10th ed.) 19. 1871.—Husnot, Musc. Gall. 362, *pl. 104.* 1894.—Dixon & Jameson, Stud. Handb. 449. *pl. 56.* 1896.

Amblystegium curvipes Guembel, Bry. Eur. Ambly. 14. *pl. 7.* 1853.—Schimper, Syn. Musc. Eur. (1st ed.) 597. 1860. (2d ed.) 717. 1876.—Macoum & Kindberg, Cat. Can. Pl. 6 : 220. 1892.

Amblystegium ambiguum De Notaris, Epil. Bry. Ital. 144. 1869.

Amblystegium trichopodium var. *kochii* Lindberg, Acta Soc. Sci. Fenn. 10 : 275. 1872.—Braithwaite, Brit. Moss Fl. 3 : 30. *pl. 89.* 1896.

Amblystegium riparium var. *kochii* R. duBuysson, Ess. anal. gen. Ambly. 20. 1883.—Boulay, Musc. Fr. 77. 1884.

TYPE in Herb. Guembel, Berlin.

Gametophyte bisexual, of medium or large size, forming wide loose tufts, ordinarily pale, light green, to yellow : stems prostrate, 2 to 4^{cm} long, flattened or obscurely angled, 180 to 300μ in diameter, cortex well differentiated, of two to three layers of cells, these 6 to 13μ in diameter; central strand 30 to 35μ, of ten to fifteen rows of cells; cells of ground tissue 13 to 35μ in diameter ; branches prostrate, ascending or sometimes erect, 1 to 3^{cm} long : leaves *long acuminate from a broadly-ovate or ovate base*, acumen slender, two-thirds the length of the body, sometimes equaling it or even longer; leaf attaining greatest width in the basal eighth, varying from serrulate in the middle leaf region to distinctly serrate throughout, costate, costa distinct, extending through two-thirds to three-fourths the length of the leaf, ceasing in the base of the acumen, one-sixth to one-fifth the leaf base at the line of insertion, 60 to 85μ wide ; many ranked, *commonly widely spreading from the base in all directions*, scarcely different in the dry condition, more or less crowded, 530μ wide by 1400μ long, ranging in width from 350 to 640μ and in length from 1100 to 1500μ; leaf cells parenchymatous in basal eighth, prosenchymatous above, cells of alar region oblong to short oblong, occasionally quadrate, 15.7μ wide by 25.8μ long, varying in width from 11 to 17μ and in length from 18 to 28μ, the marginal two to three

rows narrower than those toward the costa, the latter 17 to 26μ wide by 40 to 60μ long, walls moderately thickened, above the cells pass rapidly through hexagonal or rhomboidal along the margin to almost linear hexagonal at the middle region, 10.4μ wide by 54μ long, varying in width from 9 to 11μ and in length from 45 to 60μ, rarely reaching 100μ, in the apical region, cells essentially like those of the middle region, 10.7μ wide by 56μ long, varying in width from 9 to 11μ and in length from 40 to 68μ; perichætial leaves ovate lanceolate to oblong lanceolate, the outer spreading, the inner erect, all costate, serrate above.

Sporophyte medium to large: seta 2 to 4.5^{cm} long, 225 to 325μ in diameter, cortex of three to four layers of incrassate cells, 8.5 to 17μ in diameter: central strand large, 43 to 52μ in diameter, of thirty to forty-five rows of cells; cells of ground tissue 9 to 33μ in diameter: capsule oval to short cylindric, asymmetric, moderately incurved from an erect base to horizontal or cernuous, pale throughout or darker on the convex side, constricted under the mouth when dry; collum small, one-sixth to one fifth the sporangium; cells of exothecium mostly parenchymatous throughout, occasionally prosenchymatous on the convex side, cells on the concave side 38.5μ wide by 51.5μ long, ranging from 26 to 64.5μ wide and from 35 to 85μ long, those of the convex side 33μ wide by 105μ long, varying in width from 18 to 47μ and in length from 55 to 180μ; cell walls 2 to 3μ thick, three to six rows of cells under the peristome smaller, hexagonal, isodiametric or occasionally transversely elongated, 10.7 to 40μ long by 17 to 34μ wide; stomata thirty-five to forty-five to the capsule, 42μ wide by 57μ long, scattered; teeth of peristome linear lanceolate, yellowish brown at base, margined, margin narrow below, abruptly wider at the middle, passing into the hyaline tip, upper half of teeth serrate, transversely striate on the back in the basal half, coarsely papillose above; endostome equaling the teeth, yellow, densely and coarsely papillose throughout, membrane not equaling the segments; the latter narrowly lanceolate, strongly carinate, open along the keel between the articulations, cilia two, occasionally

one or three, nodose to imperfectly appendiculate, usually shorter than the segments, occasionally equaling them ; operculum as wide as the capsule, blunt pointed from a convex base : spores finely papillose, 16μ to 23μ in diameter : calyptra equaling the capsule or nearly so, split half its length.

HAB.: In moist shady places on earth. Type locality Germany.

Europe, Asia, North America : District of Columbia, Minnesota(?), Kansas. Not common.

Closely related to *A. riparium*, the smaller forms of which it resembles. It may generally be known from these by the long slender acumen and serrate margin of its leaves. It may be confused with large forms of *A. varium*. The leaves of the latter are commonly shorter pointed and have the leaf cells smaller throughout and especially shorter at the base.

AMBLYSTEGIUM VACILLANS (Sulliv.). *Plate XII. fig. 4.*

SYNON.: *Amblystegium vacillans* Sullivant, Mss. 1870. Icon. Musc. Suppl. 96. *pl. 72.* 1874. Macoun & Kindberg, Cat. Can. Pl. 6:222. 1892.
Hypnum vacillans Lesquereux & James, Man. Moss. N. Amer. 377. 1884.

Gametophyte bisexual, medium to large, loosely cespitose, pale yellowish green : stems prostrate or floating, sparingly branched, 2 to 6^{cm} long, 175 to 385μ in diameter; central strand poorly differentiated, 20 to 30μ in diameter, composed of six to ten rows of large cells, 6.5 to 12μ in diameter ; cortex of three to five layers of cells 6 to 17μ, those of the ground tissue abruptly larger, 17 to 35μ; branches short, 1 to 2^{cm} long : leaves lanceolate to oblong lanceolate, attaining greatest width in basal third, acuminate or acute, *tip broad and blunt*, slender, *entire*, costate, costa distinct, extending three-fourths to four-fifths the length of the leaf, about one-seventh the leaf base at line of insertion, 35 to 47μ wide; many ranked, complanate or equally spreading on the branches, open erect, in small plants 400μ wide by 1340μ long, ranging from 330 to 450μ wide and from 1050 to 1550μ long, in larger plants reaching 685μ wide by 2150μ long; leaf cells parenchymatous at base, leaf ordinarily separating from the stem leaving at the basal angle a small group of quadrate or

short oblong cells, 13μ wide by 22μ long, varying in width from 10 to 15μ and in length from 18 to 25μ, sometimes below these is a row of slightly inflated and elongated cells across the base 20 to 26μ wide by 40 to 50μ long, the cells in the one or two marginal rows at the base frequently much elongated, reaching 100μ, in all parts of the leaf above the basal eighth cells prosenchymatous, in the middle region linear, 8.3μ wide by 49μ long, ranging in width from 6.5 to 9μ, and in length from 40 to 56μ, *in the apical region shorter, slightly wider and more or less irregular, oval, hexagonal or rhomboidal*, 8.6μ wide by 23.5μ long; outer perichætial leaves triangular, reflexed from the middle, the inner lanceolate or oblong, erect, all acuminate, costate, costa vanishing in the acumen, entire.

Sporophyte medium, 1.5 to 25^{cm} long: seta brown below, paler above, slender; capsule light brown when old, 1.5 to 2^{mm} long, cylindrical, oval or obovate, asymmetric or rarely almost symmetric, from erect to incurved, not constricted under the mouth when dry; collum one-sixth to one fourth the length of the sporangium; cells of the exothecium irregular, mostly parenchymatous throughout, somewhat prosenchymatous on the convex side, cells on the concave side 32μ wide by 50μ long, varying in width from 15 to 47μ and in length from 21.5 to 77μ, on the convex side 28μ wide by 62μ long ranging from 13 to 38.5μ wide and from 25 to86μ long; three to six rows of cells under the mouth transversely elongated, hexagonal, 21.5 to 43μ wide by 8.6 to 25.8μ long; cells walls 3 to 4μ thick; stomata twenty to thirty to the capsule, scattered, 32μ wide by 38μ long; peristome teeth narrowly lanceolate, brown below, pale above, narrowly margined, transversely striate on the back below the middle, papillose above, serrulate above; endostome pale, papillose throughout, faintly so on the membrane, this only one half the length of the segments, segments linear lanceolate, carinate, open along the keel between the articulations, cilia one or two, short, one half the length of the segments, nodulose; operculum conic; annulus narrow, of one row of cells: spores finely puncticulate, 13 to 18μ in diameter: calyptra not seen.

HAB.: That of *A. riparium*. Type locality White Mountains, New Hampshire.

North America: New Hampshire, New Jersey, Ontario. Rare.

Closely related to *A. riparium*. It may be known by the irregular and usually very short cells in apical region of the leaf and the wide blunt tips of the branch leaves.

UNIVERSITY OF WISCONSIN.

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EXPLANATION OF PLATES XI–XIII.

The leaf outlines were magnified 85 diameters in the original drawing; the cells from the three leaf regions 580 diameters; *fig. 3l* (*pl. XII*), 340 diameters; *fig. 3f* and *3f.'*, and *3g* of the same plate 160 diameters; and *3h* 10 diameters. All originals reduced one half.

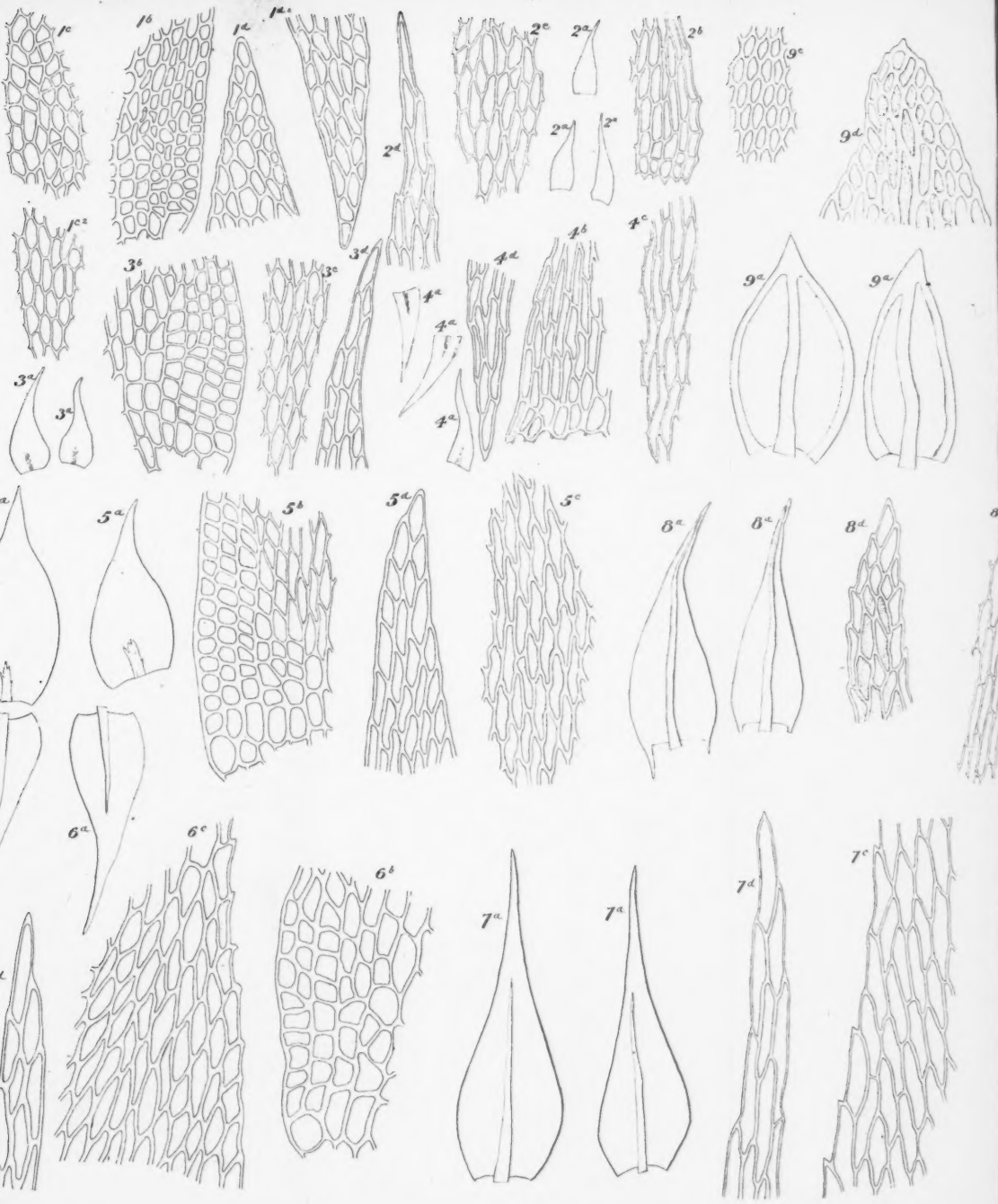
PLATE XI.

FIG. 1. *A. confervoides: a*, leaf; *b*, cells from the alar region; *c*, cells from the middle region in American plant; c^2, cells from the middle region in European plant; *d*, cells from the apical region in American plant; d^2, cells from the apical region in European.

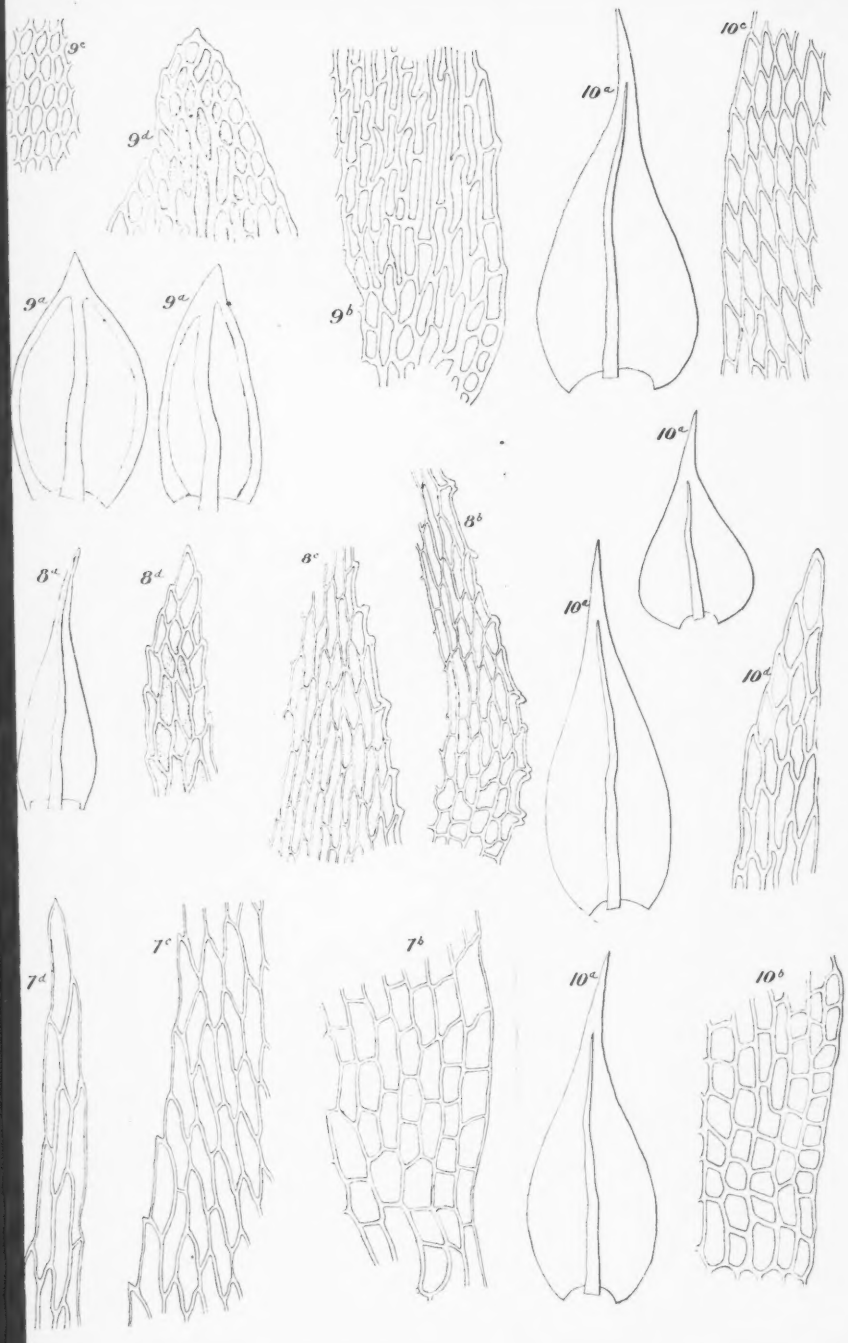
FIG. 2. *A. sprucei: a*, leaf; *b*, cells from the alar region; *c*, cells from the middle region; *d*, cells from the apical region.

FIG. 3. *A. subtile: a*, leaf; *b*, cells from the alar region; *c*, cells from the middle region; *d*, cells from the apical region.

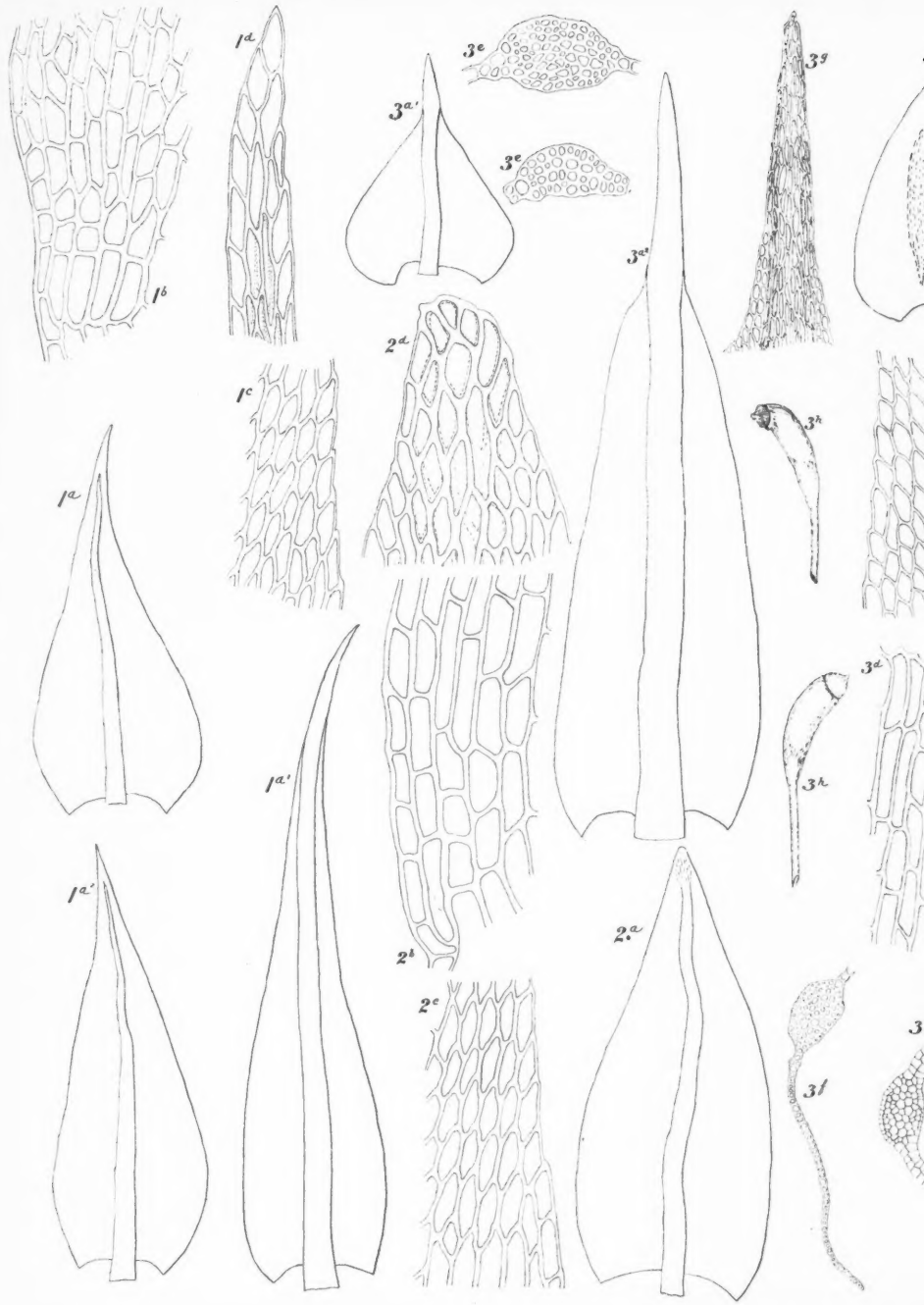
FIG. 4. *A. minutissimum: a*, leaf; *b*, cells from the alar region; *c*, cells from the middle region; *d*, cells from the apical region.



CHENEY on AMBLYSTEGIUM.



LYSTEGIUM.


1b
1d
3e
3a'
3e
3g
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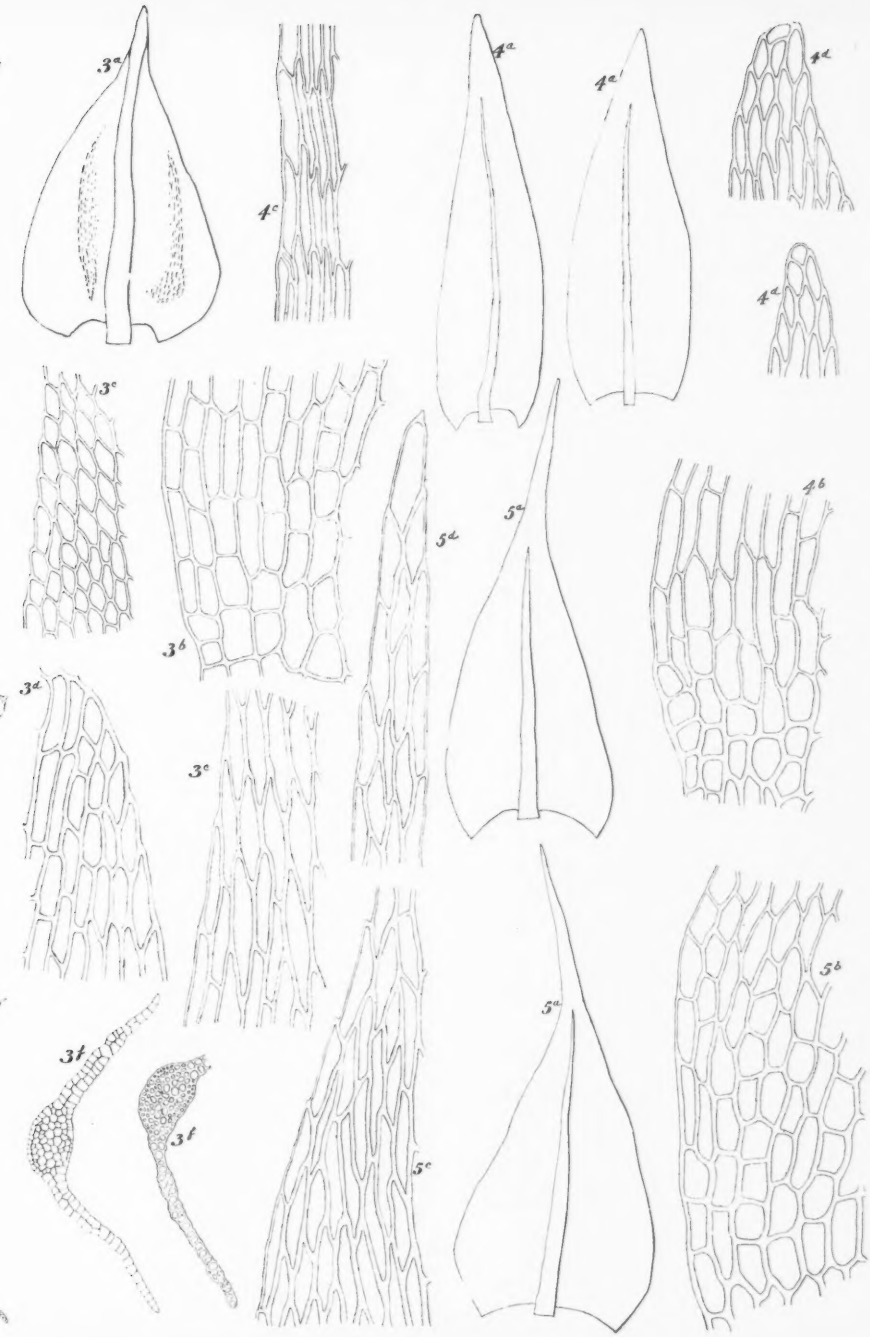
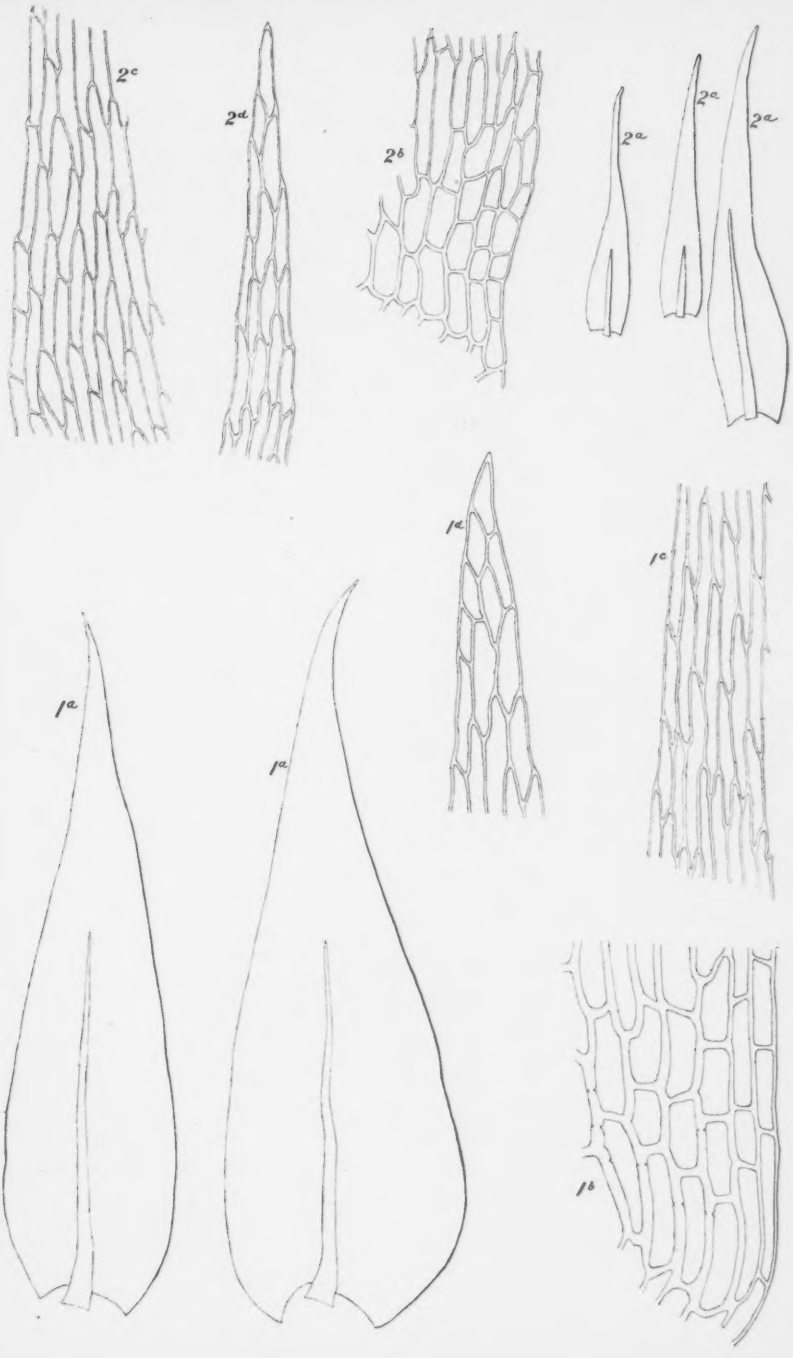


MBLYSTEGIUM.



CHENEY on AMBLYSTEGIUM.

FIG. 5. *A. adnatum:* *a*, leaf; *b*, cells from the alar region; *c*, cells from the middle region; *d*, cells from the apical region.

FIG. 6. *A. serpens:* *a*, leaf; *b*, cells from the alar region; *c*, cells from the middle border region; *d*, cells from the apical region.

FIG. 7. *A. juratzkanum:* *a*, leaf; *b*, cells from the alar region; *c*, cells from the middle border region; *d*, cells from the apical region.

FIG. 8. *A. compactum:* *a*, leaf; *b*, cells from the alar region; *c*, cells from the middle border region; *d*, cells from the apical region.

FIG. 9. *A. lescurii:* *a*, leaf; *b*, cells from the alar region; *c*, cells from the middle region; *d*, cells from the apical region.

FIG. 10. *A. varium:* *a*, leaf; *b*, cells from the alar region; *c*, cells from the middle border region; *d*, cells from the apical region.

PLATE XII.

FIG. 1. *A. irriguum:* *a*, leaf; a^1, leaf of the variety *spinifolium*; *b*, cells from the alar region of a^1; *c*, cells from the middle border region of a^1; *d*, cells from the apical region of a^1.

FIG. 2. *A. fluviatile:* *a*, leaf; *b*, cells from the alar region; *c*, cells from the middle border region; *d*, cells from the apical region.

FIG. 3. *A. noterophilum:* *a*, leaf; a^1, leaf, terrestrial form; a^2, leaf, large aquatic form; *b*, cells from the alar region; *c*, cells from the middle border region; c^1, cells from the middle border region, terrestrial form; *d*, cells from the apical region of lamina; *e*, transections of the costa at the middle of the leaf and just above the lamina; *f*, transection of leaf near its base; f^1, transection of leaf near its middle; *g*, tip of the leaf of the large aquatic form; *h*, capsule.

FIG. 4. *A. vacillans:* *a*, leaf; *b*, cells from the alar region; *c*, cells from the middle border region; *d*, cells from the apical region.

FIG. 5. *A. kochii:* *a*, leaf; *b*, cells from the alar region; *c*, cells from the middle border region; *d*, cells from the apical region.

PLATE XIII.

FIG. 1. *A. riparium:* *a*, leaf; *b*, cells from the alar region; *c*, cells from the middle border region; *d*, cells from the apical region.

FIG. 2. *A. riparium floridanum:* *a*, leaf; *b*, cells from the alar region; *c*, cells from the middle border region; *d*, cells from the apical region.

BRIEFER ARTICLES.

VERNATION OF CARYA.

THE bud of our common shellbark hickory, known in New England as walnut, is as beautiful as a flower. Its vernation and evolution are most interesting.

Before it opens, the very large bud consists of a series of imbricated scales, coarse and papery without, but as they are successively removed growing more delicate until finally they become of satiny sheen and texture. These inner scales are, moreover, pubescent, with close, silky

hairs. The shape of the scales changes rapidly with the centripetal advance. The outer and smaller ones are nearly orbicular. From this shape they broaden into ovate, and then into oblanceolate. It will happen in some buds, not in all, that scales will occur showing a retuse apex; then some more deeply emarginate and much narrower. Lastly, there will be one showing in the apical cleft a trace of true pinnation in the leaves.

The foliage proper consists of leaves, varying in number, standing erect upon the petioles and convolutely packed. Each of the leaflets is involutely rolled, and all are closely appressed. A sticky and sweetly odorous exudation helps to guard the leaves.

In full development the inner scales, several inches in length, become reflexed, and, with their beautiful salmon color, passing into green, or even of a rich claret red, resemble the petals of some gorgeous flower.—WILLIAM WHITMAN BAILEY, *Brown University*.

ABNORMAL LEAVES AND FLOWERS.

MR. FOERSTE's interesting article on "Curious leaves" in the June GAZETTE induces me to place on record a couple of instances which I have lately observed here in Mesilla. One day Professor E. O. Wooton brought in a handful of *Clematis ligusticifolia*, which was placed in a bowl for ornament. Looking over it, I was surprised to see that many of the flowers had two of the petaloid sepals coalesced for more than half their length (*fig. 1*, from a dried flower).

FIG. 1.

FIG. 2.

At about the same time, raising some *Solanum elæagnifolium* from seed, I found a seedling in which the cotyledons were coalesced for over half their length (*fig. 2*), so that the plant was no longer dicotyledonous.

These examples, as also, perhaps, Mr. Foerste's *figs. 1* and *2*, are the result of abnormal coalescence. In the case of Mr. Foerste's elm leaves the interpretation is more obscure; but at all events, they have nothing to do with the other cases figured (*figs. 3* and *4*) by Mr. Foerste, in which we have simply an arrest of the central axis.

There is a cottonwood (*Populus Fremontii*) here in Mesilla which

produces growths having the form of bunches of grapes, consisting of great numbers of stalks on a central axis, each bearing a dense rounded mass of small aborted leaves.—T. D. A. COCKERELL, *Mesilla, N. M.*

STOMATA ON THE BUD SCALES OF ABIES PECTINATA.

IN the Metaspermæ stomata occur on all normal leaves. They are also usually found on all of their well developed bud scales.

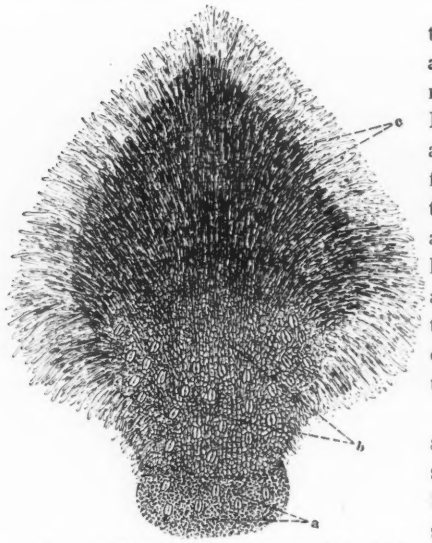


FIG. 1.—Dorsal surface of one of the bud scales of *Abies pectinata*, with stomata; *a*, a part of the axis and decurrent swelling, or pulvinus at the base of the scale; *b*, part of the scale which was covered over by the next lower bud scales, showing stomata; *c*, part of the scale which was exposed to the atmosphere. Epidermal cells thick walled and sclerotic. No stomata.

The needle like leaves of the Coniferæ are smaller, and hence have fewer stomata than the leaves of the Metaspermæ. On this account one would expect to find fewer or no stomata on their morphological equivalents, the bud scales. This has been found to be true, and it has always been thought that stomata never occur on the bud scales of the Coniferæ.

Grüss[1] says that stomata are never present on the bud scales of the Coniferæ. Schumann[2] makes the same statement. In a recent paper[3] the writer called attention to the occurrence of stomata on the bud scales of *Abies pectinata*.

Normal leaves of *A. pectinata* have stomata only on their lower surfaces, where

[1] GRÜSS, J.: Beiträge zur Biologie der Knospe. Jahrbücher für wissen. Botanik 23:642.

[2] SCHUMANN, C. R. G.: Anatomische Studien über die Knospenschuppen von Coniferen und dicotylen Holzgewächsen. Bibliotheca Botanica 15:3. 1889.

[3] Ueber abnorme Bildung von Harzbehältern, etc. Sonderabdruck aus der Forst.-naturw. Zeitsch. 1896. S. 15.

they are arranged in two bands, one on each side of the mibrid of the leaf. Each band is made up of from nine to fourteen rows of stomata. The stomata are never found on the midrib of the leaf.

The presence of stomata on the bud scales can best be demonstrated by mounting them in chloral hydrate. This clearing agent will make the scale more transparent, cause considerable swelling of the cell walls, and increase the guard cells of the stomata to their original size, rendering them visible from the exterior.

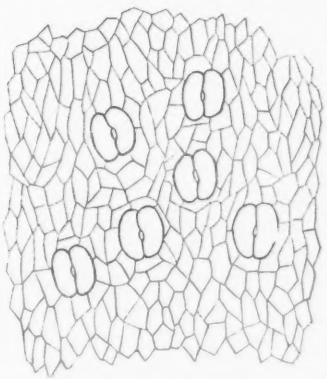


FIG. 2.—Highly magnified portion of dorsal side of a scale with stomata.

In the bud scales, as in their morphological equivalents, the leaves, the stomata are found only on the dorsal or lower surface of the scale. They are found only near the base of the scale and on that part of the epidermis which was covered over in the bud by the next lower scales. The cells of this part of the epidermis never become sclerotic, but remain thin walled (*fig. 1, b*). The exposed epidermal cells become sclerotic, and stomata never occur on this portion of the scale (*fig. 1, c*).

Stomata are found also on the axis of the bud and on the decurrent swelling or pulvinus of the scale (*fig. 1, a*). Stomata are found on the pulvini of all the scales, but on the scale laminæ they occur only on the larger and well developed ones. They are found on the outer or lower exposed scales, as well as on the inner or upper ones. The stomata are not as regularly distributed in rows as they are on the leaves. They are found isolated and in groups, occurring also on the midrib portion of the scale itself.—ALEXANDER P. ANDERSON, *Clemson College, South Carolina.*

CURRENT LITERATURE.

MINOR NOTICES.

A SEPARATE from the Transactions of the Wisconsin Academy of Sciences has been distributed by Dr. Davis.[1] In it 73 species of parasitic fungi are given that have been detected in the state since the publication of the last list in 1893, and additional hosts for 58 previously published species are recorded. *Entyloma Floerkeæ* Holw. and *E. Castaliæ* Holw. are probably described here for the first time; the latter occurs on Nymphæa and Nuphar. *Ustilago longissima macrospora* Davis is said to differ from the type in its "larger spores, 6–11 μ, mostly 8–9 μ in diameter."—J. C. A.

DR. WILLIAM TRELEASE[2] has published the results of his botanical observations on the Azores. The author visited those isolated islands in the summers of 1894 and 1896, and in addition to his own collections also enumerates plants previously reported from the islands. A brief discussion of the ecological features precedes the catalogue. There are few endemic species, and few pollinating insects. "The greater part of the Azorean flowering plants are either anemophilous or adapted to pollination by the aid of little-specialized insects, and, as a rule, they have open flowers with readily accessible nectar or pollen." The list includes cryptogams as well as phanerogams.—J. M. C.

IN CONTINUATION of his studies of Mexican and Central American plants, Dr. J. N. Rose[3] has just published an important contribution. Instead of reporting upon the many separate collections, a method which badly scatters material, Dr. Rose has determined to discuss genera, families, etc., upon the basis of all available material. In the present contribution the following subjects are presented: Notes on Celastraceæ; Notes on Rutaceæ, in which the genus Esenbeckia is enlarged to five species, three of which are figured; Notes on Burseraceæ; Notes on Cucurbitaceæ, among which is a discussion

[1] DAVIS, J. J.—Second supplementary list of parasitic fungi of Wisconsin. From Trans. Wis. Acad. Sciences 11: 165–178. 1897.

[2] TRELEASE, WILLIAM.—Botanical observations on the Azores. From the eighth Annual Report of the Missouri Botanical Garden, pp. 77–220, *pl. 12–66*, September 9, 1897.

[3] ROSE, J. N.—Studies of Mexican and Central American plants. Contrib. U. S. Nat. Herb. 5: 109–144. 1897.

of the genus Echinopepon and its allies, a number of new species being described and figured; A synopsis of the species of Heliocarpus, containing fifteen species; A synopsis of the American species of Hermannia; A synopsis of *Drymaria nodosa* and its allies; and Descriptions of miscellaneous new species, thirty-five in number, and with numerous illustrations.—J. M. C.

MR. CHAS. RICHARDS DODGE[4] has published the results of his long investigations among useful fibers. It is an enumeration of 1018 species of useful fiber plants, the more important of which are fully described and treated from the botanical, agricultural, and industrial standpoints. It is much more than a list of commercial species, for it is especially interesting in its presentation of the native fibers. The aboriginal American fibers have never before been brought together in such a complete way. The contribution is a great compendium of useful knowledge, to secure which Mr. Dodge has enjoyed special facilities. He is to be thanked for a very valuable contribution to the literature of economic botany.—J. M. C.

NOTES FOR STUDENTS.

A NEW AUXANOMETER is described by L. C. Corbett in the ninth annual report of the West Virginia Experiment Station for 1896. It is a lever instrument recording by pen upon a slowly revolving drum. The plant is attached to the short arm of the lever by platinum wire.

Other topics treated by the same writer are the greater vigor of northern grown seeds, bulbs, and cuttings, demonstrated by a large number of experiments; the behavior of cuttings, especially from tuber producing plants; and the injuries due to forest fires.

In the same report A. D. Hopkins discusses the life zones of West Virginia and the distribution of trees. The Canadian, transition, and upper austral zones can be traced, although the three marked areas of spruce, pine, and hard wood forests do not coincide with them. Three maps accompany the paper.—J. C. A.

RECENT BULLETINS from the experiment stations contain botanical matter of interest as follows: A. S. Hitchcock (Kas. no. 66, pp. 19–54) presents the fourth bulletin in a series on Kansas weeds, assisted by George L. Clothier. It is devoted to the fruits and seeds, including a description and illustration of each of the 209 species embraced in the list. The plates are

[4] DODGE, CHARLES RICHARDS.—A descriptive catalogue of useful fiber plants of the world, including the structural and economic classification of fibers. Report no. 9, U. S. Department of Agriculture. Fiber investigations. Pp. 361. *Pl. 1–12.* 1897.

admirably drawn, and bear the signature of Bertha S. Kimball. A key is arranged to aid in identification. J. W. Toumey (Ariz. no. 22, pp. 3–32) gives much general information about weeds of Arizona. In a list of 50 species nearly three-fourths are not known, or rarely seen, east of the Mississippi river. Sixteen species are singled out for more extended description, and twelve are illustrated. The only weed law of the state is directed against cockleburs and sunflowers along irrigating canals. A thick bulletin (Ore. no. 45) on prunes in Oregon, by four collaborators, contains a historical account of the varieties cultivated (pp. 21–33) and of the fungous diseases (pp. 63–75), written by U. P. Hedrick. An account of *Cicuta vagans* Greene is also given by U. P. Hedrick (Ore. no. 46, pp. 3–12, *pl. 4*). The underground parts are very poisonous while dormant, a piece the size of a walnut being sufficient to kill a cow. Two plates illustrate the plant, and two others show harmless species resembling it. F. H. Hillman (Nev. no. 33, pp. 3–13) gives notes upon a number of indigenous Nevada grasses, looking toward their utility as forage. In a bulletin by S. A. Beach (N. Y. no. 125) upon growing tomatoes under glass, two pages and one plate are given to a description of a peculiar black rot of the fruit written by F. C. Stewart. The cause was not ascertained. In the early stages no fungi or bacteria could be detected either by means of the microscope or agar cultures.—J. C. A.

Dr. Robert Bell, of the Canadian Geological Survey, gave a very interesting address before the Royal Scottish Geographical Society at Edinburgh last March on the geographical distribution of forest trees in Canada. This address has recently been published with a map.[5] The author is exceptionally well fitted for this work by reason of forty years of observation throughout Canada. He states that there are 340 species of trees indigenous to the United States, 123 of which occur in Canada, 94 being found east of the Rocky mountains. *Pinus Banksiana* is mentioned as the only tree that may be considered as belonging to Canada, entering the United States only along the south shore of Lake Superior. It seems too bad to deprive the Canadians of the only tree to which they lay claim, but the species in question is very common about Lake Michigan, extending as far south as northern Indiana. The manuals also report *Pinus Banksiana* in Maine, Vermont, and New York. Some trees, especially the more hardy species, are said to taper off gradually in size as they approach their northern limits, while others, especially the more southern species, maintain their full size. The former habit would, of course, seem natural, owing to the gradually increasing rigor northward. Dr. Bell attributes the differences to the fact that the first type have better means of distribution (*e. g.*, seeds of conifers and poplars, fitted for wind dispersal), and have had time since the Pleistocene to occupy all territory congenial to their existence. The second type (including walnuts,

[5] Scot. Geog. Mag. 13: 281–296.

basswood, etc.) migrate more slowly, and are yet far from their rightful limits. Some of the trees of the second class have been transplanted successfully far to the north of their natural habitat.

The conditions governing distribution are listed as follows: (1) Distance or proximity of the sea. Most tree lines are more or less parallel to the Atlantic ocean and Hudson bay, as a rule appearing to shun the salt water. *Pinus Banksiana*, for instance, never comes to the coast, but appears almost everywhere else, even having outliers in the center of Nova Scotia and New Brunswick. *Populus balsamifera*, however, seems to love the sea, and is absent from a vast area in the interior. (2) Geological changes in arrangement of land and water. Some erratic lines, seen especially in the balsam poplar, are probably due to peculiarities in the distribution of glacier ice. *Thuya occidentalis* has the most remarkable line of all, turning abruptly southward both in the east and west; the cause in the east is thought to be the recent insular condition of Nova Scotia. This species has a large outlier 300 miles north of its regular line. (3) General dryness or moisture. Dr. Bell makes a strong argument for drought as the cause of treeless prairies rather than forest fires; the tree lines are not sharp but concentric, and the more hardy trees have their lines farther out into the dry region. (4) Extremes of heat and cold. (5) Local heat and moisture from lakes and rivers. This usually results in a further extension northward along river courses than on the uplands. (6) General elevation above the sea. This may account for the absence of the elm and black ash in a large interior area, since they occur on all sides of this region. (7) Local elevations. (8) Local depressions. (9) Diseases and insect pests. (10) Rapid or slow means of dispersion. (11) Forest fires. These are said to be frequent as natural phenomena. After a fire there springs up a low shrub and herb vegetation, then poplars, birches, and willows in about 20 years. Conifers dominate again in 50 years and reach maturity in about 150 years.—H. C. C.

THE WEEDS of Canada are treated briefly in a bulletin (no. 28) of 39 pages from the Central Experimental farm, prepared by Dr. James Fletcher. General methods for the control and extermination of weeds are given, followed by descriptions and illustrations of the following fourteen species of weeds possessing special interest: *Sisymbrium altissimum* L., *Arabis hirsuta* Scop., *Conringia orientalis* Andrz., *Neslia paniculata* Desr., *Thlaspi arvense* L., *Lepidium apetalum* Willd., *Saponaria Vaccaria* L., *Silene Cucubalus* Wib., *Hieracium aurantiacum* L., *Cynoglossum officinale* L., *Echium vulgare* L., *Salsola Kali Tragus* Moq., *Rumex crispus* L., and *Hierochloa borealis* R. & S. The first six species belong to the Cruciferæ. Much information regarding the more prominent Canadian weeds, numbering over one hundred and sixty species, is thrown into tabular form and made easy of reference.—J. C. A.

DR. J. P. LOTSY has concluded an elaborate study on the localization of alkaloids in cinchonas, the results of which, illustrated by twenty colored plates, are to appear in Dutch. In order to render the larger work more intelligible to foreigners, he publishes in German[6] a concise account of the more important results. These are as follows:

The alkaloid is found in the contents of living parenchyma, even the nutritive parenchyma. It is not found, however, in cells containing calcium oxalate, nor in sieve tubes. In general (there are exceptions) the alkaloid in young members is dissolved in the cell sap. On the contrary, in older parts, *e. g.*, in the secondary bast of stems, it exists as a solid amorphous substance in the interior of the cells. Very active parts, such as the cambium or the apical meristem, as a rule contain no alkaloid, but at a short distance from the centers of activity it is found in large amounts.

Dr. Lotsy announces that these researches are preliminary to an inquiry into the physiological rôle of the alkaloid in the plant, investigations in this direction having already been begun.—C. R. B.

IN THE *Botanisches Centralblatt* (**70**: 184–189. 1897) Dr. R. Kolkwitz, has a useful summary of the literature on the movements of swarm spores, spermatozoids, and plasmodia, and their dependence upon external factors. He covers the period from 1885 to 1896, and gives a list of 75 papers.—C. R. B.

AMANN recommends[7] the following fluid, which he calls lactophenol, as a medium for restoring dried mosses, algæ, etc., to their natural size, and for mounting them: crystallized phenol, c. p., 20^{gm}; lactic acid (sp. gr. 1.21), 20^{gm}; glycerin (sp. gr. 1.25), 40^{gm}; distilled water, 20^{gm}. Herbarium material should first be warmed in dilute lactophenol and then treated with the pure. Five per cent. lactophenol in water, to which is added 0.2 per cent. each of copper chloride and copper acetate, is specially adapted to the preservation of algæ.—C. R. B.

CHODAT has exposed spores and developing mycelium of *Mucor Mucedo* to a temperature of $-70°$ to $-110°$ C. for several days without killing them. The low temperature did not better the capacity of the spores for germination, as Eriksson found a temperature of $-12°$ C. did for spores of Uredineæ.[8] —C. R. B.

DR. J. GRÜSS summarizes the results of a recent installment of his "Studien über Reservecellulose"[9] thus:

[6] Bot. Centralblatt **71**: 395. 1897.

[7] Zeitschr. f. wiss. Mikros. **13**: —. 1897.

[8] Bot. Centralblatt **70**: 242. 1897.

[9] Bull. de l'Herbier Boissier **4**: —. 1896. Cf. Bot. Cent. **70**: 267. 1897.

In germination the diastatic enzyme penetrates from the cell lumen into the thickened cell wall, the more copiously the nearer the scutellum. [The seed under investigation was *Phœnix dactylifera.*] Upon the penetration of the enzyme there follows a fractional hydrolytic solution by which galactan is removed from the cell wall. This produces the hyaline marginal zone. The mannin remain ingin this hyaline zone succumbs to alloolysis; that is, the mass penetrated by the enzyme passes into various stages of mannin and finally into mannose. According to the reactions one can distinguish a leucomannin and a cyanomannin.—C. R. B.

PHYSIOLOGISTS will find in the *Pharmaceutical Review* for September two valuable articles touching the chemistry of plants. One is a summary of recent literature on oak bark tannins *à propos* of some researches on the caffein compound of kola (**15**: 172) by Knox and Prescott. The other is a résumé of progress in the chemistry of the carbohydrates during 1896, by W. E. Stone (**15**; 178).—C. R. B.

MONTEMARTINI has prosecuted researches upon the physiology of the primary and secondary meristem of various plants.[10] He finds that the activity of the growing point shows a grand period dependent upon internal factors. There exists a connection between apical and secondary growth; the curve of the former is parallel with that of the latter; the maximum of apical activity corresponds to the greatest elongation of the growing zone; both are equally affected by external agents. The secondary meristem shows a like periodicity, independent, however, of that of the apical region.

The author also discusses the formation of annual rings. He concludes (with Jost and Mer) that their production is an immediate consequence of spontaneous and periodic variations in the activity of the cambium, and (with Unger) that the periodicity of the cambial activity, though independent of that of the primary meristem, is synchronous with it and influenced, like it, by external conditions.—C. R. B.

ANCIENT EGYPTIAN bread taken from the tomb of Mentuhotep and now in the Royal Museum at Berlin is found by L. Wittmack[11] to still give the iodine test for starch. Microscopical study shows it to be made from barley, and to contain the remains of yeast and bacteria. This indicates that barley is probably older as a cultivated grain than wheat, and that yeast, or dough of the previous baking, was doubtless used in those ancient times. The bread is estimated to be fully 4400 years old.—J. C. A.

[10] Atti dell Istit. Bot. della Univ. di Pavia II. **5**: —. 1896. Cf. Bot. Centralblatt **70**: 276. 1897.

[11] Bot. Centr. **71**: 328. 1897.

PROFESSOR BELAJEFF has recently published two preliminary papers announcing important discoveries in the spermatogenesis of Filicineæ[12] and Equisetineæ[13]. This author has previously given considerable attention to the process of spermatogenesis in various groups of plants, and his critical work on the spermatogenesis of the Characeæ led largely to the establishment of the view that the body of the spermatozoid is formed not only of the nucleus but also of the cytoplasm of the cell. His recent studies on the Filicineæ and Equisetineæ, he announces, have given him many opportunities to observe the correctness of this view. The main object of the present preliminary papers is to call attention to the office of an organ discovered in the spermatic cells, which ultimately forms a spiral band from which the cilia of the spermatozoid are developed.

In the spermatic cells of ferns, fixed with vapor of osmic acid and stained with a mixture of iodine green and fuchsin, small round bodies were found which stained very intensely. They are located in the cytoplasm near the nuclear wall, which is frequently somewhat indented at this point. These spheres reminded the author of centrosomes, and a careful examination was thus made of the dividing cells of the spermatic tissue. However, no indication of a centrosome could be detected. The first change which takes place in the spermatic cell is the gradual extension of this sphere, which becomes crescent shaped, and finally develops into a thread which encircles the nucleus. By a very careful examination the author was able to determine that this thread, which stains very intensely, runs along the edge of a lighter stained band which represents the first foundation of the body of the spermatozoid. It lies in the cytoplasm and stains bright red. In its further extension this band assumes the form of a spiral (apparently helicoid, judging from the author's description), of which the extended turns of the rear end encircle the nucleus, while the much smaller turns of the front end or apex of the spiral terminate free in the cytoplasm of the cell. The cilia, which are at first short but gradually increase in length, arise from the front end of this spiral and are directed backward. While the band is developing, the nucleus of the spermatic cell also undergoes considerable change. It begins to stretch out along the spiral band, becoming first reniform, then crescent shaped, and finally assumes a spiral form, the rear end of which is much the thickest. In the mature spermatozoid the hinder part consists of a spiral shaped, dense nucleus, which is surrounded by a layer of cytoplasm. On the rear end a continuation of the layer of cytoplasm forms an appendage. The front end of the spermatozoid has a band-like form, reacts the same as cytoplasm, and appears to be a continuation of the surrounding layer of cytoplasm. A thin

[12] Ueber den Nebenkern in spermatogenen Zellen und die Spermatogenese bei den Farnkräutern. Ber. d. deutsch. bot. Ges. **15**: 337–339. 1897.

[13] Ueber die Spermatogenese bei den Schachtelhalmen. Ber. d. deutsch. bot. Ges. **15**: 339–342. 1897.

thread, staining intensely with fuchsin, runs along the upper edge of this plasma band, which is the spiral thread or band formed by the extension of the sphere. The cilia, somewhat over forty in number, are attached to the two front turns of the spiral body of the spermatozoid, which in the mature condition does not have more than three turns.

In the spermatic cells of the Equisetineæ the bodies associated with the nucleus are not round as in the ferns, but crescent shaped, with the convex side turned toward the nucleus. Here, as in the ferns, the first change observed in the metamorphosis of the spermatic cell is in this body, which changes its form, turning its concave side toward the nucleus, around which it then begins to extend. It soon assumes a thread-like form and encircles the nucleus in the form of a spiral. Here also, as in the ferns, the writer was able to discover that an intensely colored thread runs along the edge of a less intensely stained band. The gradually elongating thread, which appears at first to be homogeneous, when it has completed its extension becomes granular. Small knobs then appear on the thread, which gradually become hook shaped, and finally extend into thread-like outgrowths, which form the cilia of the mature antherozoid. While the spiral thread and band are developing, the nucleus gradually elongates, as in the ferns, and finally assumes the form of a short spiral.

The mature spermatozoid has the form of a spiral with about two turns, and bears a large number of cilia on the front turn. The anterior portion of the spermatozoid appears as a comparatively small band, while the posterior portion forms a much thicker body and contains the nucleus which, as in the ferns, is surrounded by a sheath of cytoplasm. The thread which is formed from the crescent shaped body of the spermatic cell runs along the upper edge of the front end of the spiral.

In the Equisetineæ Belajeff was able to trace plainly the development of the cilia from the spiral thread formed by the extension of the crescent shaped body. In the ferns this connection was not traced, but from the analogy of the two cases, the author thinks there can be no doubt but that the spherical body (*Nebenkern*) in the ferns performs the same function.

By comparing these results with his previous studies of the spermatogenesis in Characeæ, the writer thinks that the tubercle (*Höcker*), which he found there in the spermatic cells, corresponds to the cilia forming body in the Equisetineæ. The tubercle, which has also been observed by Strasburger, lies near the nucleus, and becomes extended into a thread that ultimately bears the two cilia.

In a third preliminary paper Belajeff discusses the similarity of the phenomena of spermatogenesis in animals and plants.[14] The changes in the form

[14] Ueber die Aehnlichkeit einiger Erscheinungen in der Spermatogenese bei Thieren und Pflanzen. Ber. d. deutsch. bot Ges. **15**: 342–345. 1897.

and structure of the nucleus occurring in the metamorphosis of the spermatic cells of the salamander, as described by Flemming, the writer claims are similar to the changes which he has observed to occur in the spermatogenesis of the Filicineæ, Equisetineæ, and Characeæ. It is further pointed out that Hermann has described the occurrence of a small body (*Nebenkern*) near the nucleus in the spermatic cells of the salamander. Belajeff believes this *Nebenkern* to be homologous with the cilia forming body which he has discovered in the Equisetineæ and Filicineæ.—HERBERT J. WEBBER.

NEWS.

ASSISTANT PROFESSOR DR. W. DETMER, of the University of Jena, has been promoted to a full professorship.

PROFESSOR DR. HANS MOLISCH has left Prag for the winter, which he will spend in botanical research at Buitenzorg, Java.

PROF. DR. HUGO DE VRIES has declined the call to the University of Würzburg as the successor of Professor Julius von Sachs.

PROFESSOR A. W. BENNETT, long the editor of the department of botany of the *Journal* of the Royal Microscopical Society, has been made editor-in-chief.

IT IS ANNOUNCED that the ten years' supplement to the *Index Kewensis*, which brings the work down to the end of the year 1895, will be issued during the present year.

DR. W. ROTHERT, of Kazan, has been appointed professor of botany and director of the physiological division of the botanical department of the University of Charkow.

PLATES nos. 19 and 20 of Lloyd's Photogravures of American Fungi show *Lycoperdon pulcherrimum* B. & C. and *Trametes serpens* Fr., and are fine examples of most successful photographic work.

A VALUABLE REVIEW of publications on agricultural botany issued in France during 1896 is given in *Experiment Station Record*, nos. 10 and 11 (8:841–853, 940–950). It was prepared by Edmond Gain of the University of Nancy.

DR. O. LOEW has given up his work in the Imperial University of Tokyo on account of impaired health. On the occasion of his departure a large gold medal was presented to him by his colleagues and students as a token of their appreciation.

PROFESSOR LESTER F. WARD recently delivered a series of five lectures, illustrated by lantern slides, on "The evolution of plants from the standpoint of paleobotany," before the students of the botanical and geological departments of the University of Chicago.

THE ADDRESS of Dr. William Trelease, on "Medical Botany," presented last June to the section on materia medica, pharmacy and therapeutics, at the forty-eighth annual meeting of the American Medical Association, at Philadelphia, has just been distributed as a reprint from the *Jour. Amer. Med. Ass.*

THE BOTANICAL SOCIETY of Western Pennsylvania (Pittsburg) has met with great success in its series of popular monthly lectures. The natural orders of plants were explained and illustrated by Mr. Wm. Falconer on the evening of September 2 to a crowded audience. The illustrative material represented 79 orders and 215 genera, and often several species for each genus; it was donated to the society by Mr. John Dunbar, of Rochester, N. Y., Mr. Henry A. Dreer, of Philadelphia, and the superintendent of Schenley Park, Pittsburg. This was the fourth lecture of the series.

ATTENTION should be called to another botanical journal which has entered the field as a popular magazine. *The Asa Gray Bulletin*, with its June number, ceased to be the organ of a chapter of the Agassiz Association, and entered upon the larger field. As was said in a recent notice of the newly established *Plant World*, there is abundant demand for a journal of this type. With G. H. Hicks as editor in chief, A. J. Pieters and C. C. DuBois as associate editors, and L. H. Dewey as business editor, we anticipate for the journal a most worthy support. *The Asa Gray Bulletin* is published bimonthly at Washington, D. C., and the subscription price is fifty cents.

WITH ITS September number, the *American Naturalist* comes into possession of new proprietors and under the charge of new editors. It makes no large promises, but seeks to define its *raison d'être*. The new editor, as already announced, is Dr. R. P. Bigelow, of Boston; while among the associate editors we find the names of the following botanists: C. E. Bessey, D. H. Campbell, H. M. Richards, E. F. Smith and W. Trelease. There is certainly a field for such a journal, and the responsible names connected with it are pledges of a very high character. In the first number the department of botany does not express itself very prominently, but it will doubtless make itself felt later.

AN INTERESTING LIST of the mycologic flora of the Kew gardens has been published in the *Bulletin of Miscellaneous Information* for April. It is a rich flora, as is perhaps to be expected when one considers the large annual influx of plants to Kew from all parts of the globe. "By this means microscopic fungi, parasitic or saprophytic, on plants are introduced in a living condition on the various hosts; whereas the higher forms, belonging to the Agaricineæ and the Gastromycetes, are usually included along with soil, or frequently on the trunks of tree ferns, either in the form of spores or in an undeveloped condition." It is interesting to note that the Polyporeæ and Thelephoreæ, so abundant in the tropics, are not represented in the list as

introduced species; and that Kew has never been responsible for the introduction into Europe of a single destructive parasite. The list enumerates 1340 species, representing 337 genera.

DR. J. N. ROSE returned from his Mexican trip early in October. His work was mostly confined to the little-known parts of the Sierra Madre. He visited Guaymas, La Paz (L. C.), Mazatlan, and Acaporeta on the western side, crossed the two ranges of the Sierra Madre north of the Acaporeta, and made two excursions into them, one from the west at Rosario, and the other from the east at Bolanos, the latter being one of Seeman's stations. The states chiefly explored were Durango, Jalisco, Zacatecas, and the territory of Tepic. The collection contains 2000 numbers, and is especially rich in umbellifers, agaves, and orchids, many living specimens of the two latter groups having been shipped for cultivation.

THE SEABOARD AIR LINE railroad, which extends from Portsmouth, Va., to Atlanta, Ga., has inaugurated a novel system of instruction of the communities along its territory. It began by encouraging tree planting and village improvement. During the present season it has been holding one-day farmer's institutes, all illustrative material and appliances, and the force of instructors being transported from place to place in a train of cars especially fitted up for the work. Another feature is the establishment of experimental farms every ten miles along the whole line; twenty-eight are now organized. Among the crops being tested are hops, ginseng, Kafir corn, and pyrethrum; fruits and grasses will be taken up in due course of time. Both the community and the railroad, and even the country at large, should profit by such well devised philanthropy.

THE LATE Dr. Edmund Russow, of the University of Dorpat (now officially known in Russia as Jurjew), left two important collections, which the widow desires to sell. One is a collection of about 3750 finely prepared and well preserved microscopical preparations. It is especially valuable because it includes the original mounts used for the late owner's classical investigations. Thus there are about 400 mounts connected with his investigations on the vascular cryptogams, including 125 of the anatomy and development of Marsilia, 22 of Pilularia, 32 of Equisetum, 37 of Lycopodium, 34 of Selaginella, etc. There are also the preparations for his notable investigations on wood, including 214 of Pinus, showing all ages and methods of treatment. It includes besides a set of 122 drugs. In general the preparations cover all families of phanerogams, among which might be named the Cycadeæ, Juncaceæ, Cyperaceæ, Gramineæ, Ranunculaceæ, and Cucurbitaceæ, which formed the original material for the author's publications. In the interest of science it is desirable that this collection be acquired by some institution where it may be accessible.

The second collection is the Sphagnum collection. Through his systematic and anatomical work on the Baltic Sphagnaceæ Russow was known as one of the foremost students of the group. He had intended to extend his monographic work when interrupted by death. The collection consists of 314 fascicles, and about 3000–4000 microscopical preparations, with outline sketches of the same, especially of the species which have been already worked up. In addition there are 300 photographic lantern slides of localities of the different sphagnums. It is much to be desired that this collection also be made generally accessible in some institution. It would be especially valuable for America, as it contains the European species, varieties, and forms completely and critically determined and worked over; and the exact relation of the American to the European sphagnums forms one of the interesting botanical problems. Further information regarding the collection may be obtained by addressing Frau Professor Emma Russow, Schloss-str. 15, Dorpat, Russia.